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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Forthcoming Events.

DECEMBER 6.

Sheffield Metallurgical Association:—Ordinary meeting. "The Determination of Molten Metal Temperatures," Paper by Robert S. Whipple.

Institute of Metals (North-East Coast Local Section):—Ordinary meeting at Newcastle-on-Tyne. J. E. Howson, M.Met., on "Hot Extrusion Process."

DECEMBER 7.

Institute of Metals (Swansea Local Section):—Ordinary meeting at Swansea. "Extrusion," Paper by R. Genders, M.B.E., M.Met.

DECEMBER 7-9.

Institution of Chemical Engineers:—Conference in London. Sir Alexander Gibb, G.B.E., C.B. (President).

Institute of British Foundrymen.

DECEMBER 3.

Lancashire Branch:—Lecture at Manchester on "Foundry Practice in United States of America," by E. Longden.

DECEMBER 8.

Birmingham, Coventry and West Midlands Branch:—Ordinary meeting at Birmingham. "Structure of Cast Iron," Paper by Professor D. Hanson, D.Sc.

London Branch:—Joint meeting with the Institute of Metals. "Strip Castings," Paper by W. A. C. Newman, B.Sc., F.I.C.

DECEMBER 9.

London Branch:—Annual dinner in London.

DECEMBER 10.

Newcastle and District Branch:—Ordinary meeting. "Manganese Bronze," Paper by Wesley Lambert.

East Midlands Branch:—Ordinary meeting at Loughborough. "Shrinkage Holes in Small Grey Iron Castings," Paper by P. A. Russell, B.Sc.

Scottish Branch:—Ordinary meeting at Glasgow. "Electric Furnaces," Paper by Victor Stobie. Also annual dinner.

Wales and Monmouth Branch:—Ordinary meeting at Cardiff. "Steel Making by Electric Furnace," Paper by R. J. Richardson.

West Riding of Yorkshire Branch:—Ordinary meeting at Bradford. "The Selection and Use of Refractories for Iron Foundries," Paper by C. Presswood, B.A.

Steady Progress.

A year ago we noted in these columns that the British Cast Iron Research Association had completed the first five years of its life, and we suggested that both the work achieved and the character of the Government Report upon it, then recently issued, were matters for congratulation. On Wednesday last was held the Association's annual meeting, at which appreciation was expressed of the valuable services rendered by the retiring President, Sir John Dewrance, K.B.E., and it was announced that Sir Philip Nash, K.C.M.G., had consented to succeed him. The sixth annual Report, which was also dealt with, represents the beginning of a new period. The pioneering stage is over, and we may now look for steady extension and consolidation.

It must be admitted that the industrial troubles of 1926 have tended to make the twelve months just ended a bad time for any institution of this type, and this has militated against extension, being clearly seen in the slow rate of increase in the Association's membership this year compared with the two previous years. At the same time much work of undoubted importance has been carried out during the period under review.

Particular interest attaches to the Association's work in the matter of engineering specifications. In conjunction with the Institute of British Foundrymen it has been successful in bringing to fruition the work on specifications for whiteheart and blackheart malleable, which have now been formally issued by the B.E.S.A., and these are shortly to be followed by specifications for grey iron. Information is now needed to serve the founder as consumer of such raw materials as ferro-alloys, sands, blackings, and so on, and we believe this problem to have been already envisaged by the Association.

One important form taken by the consolidation process already mentioned refers to the question of premises. In spite of the contrary example of other research associations, and the expression of some doubt as to the wisdom of the step, it will be recalled that combined and extended office and laboratory premises were acquired in the autumn of 1926. During the past year the move has fully justified itself, both by the economy and efficiency of administration that it has made possible, and by the very real assistance the extension has afforded to the Association's work. The next step in logical development along these lines would seem to be the acquisition by the Association of its own foundry premises; we understand that this is now receiving consideration, and the proposal seems worthy of all encouragement.

The possession of such premises does not, of course, interfere with the locating of investigations in members' works and foundries, to which the Association rightly attaches great importance. The co-operative nature of the organisation in this direction has previously been pointed out. The real contributions of members to the Association are not by any means covered by the subscriptions, since to these must be added time, services, labour, and accommodation ungrudgingly given. But the presence of ordinary working conditions is at once the strength and the weakness of investigations undertaken in this way, and the function of centralised laboratories and staff is the conduct of work that in the nature of things is impossible on the premises of an ordinary manufacturing concern.

The work of the Research Association is coming to be more and more widely appreciated, and as its influence and importance grows, founders who have co-operated actively with it in these early years will assuredly congratulate themselves on the part they have taken in building up what is bound to become an invaluable and indispensable asset to the whole foundry industry.

American Foundries and British Equipment.

Reading between the lines all is not well with the American grey iron foundry business, and it is authoritatively stated that "despite a considerable amount of industrial research and the widespread adoption of labour-saving machinery, the margin between operating costs and the gross income is entirely too small, and the total volume of production must continually withstand the inroads by various substitutes." Moreover, the men that matter on the other side of the Atlantic are asking a Government Department to help them by collecting fundamental data on the present position.

If American clarity of thought can solve the proposition it is reasonably certain that their deductions will be equally applicable on this side. Having studied American mentality closely for many years we feel that we can forecast the results of any examination which may be instituted. Primarily an effort will be made to unify both regionally and nationally the various foundry costing systems. Secondly, there will be a slight industrial revolution aiming at increased elasticity of manufacturing conditions, by the introduction of the unit system. Finally, there will be an intense publicity campaign to laud the properties of cast iron. But will these efforts truly re-establish what is now admitted to be the sick monkey in American industry? Clearly, they will do much, whilst real success will be achieved if they can assure something in the region of 80 per cent. adherence to the scheme, coupled with the application of

research work of a similar standard to that achieved in Britain and Europe generally. This comparison is not made with the object of belittling American efforts, but as a Continent, the standard and quantity is lower than that of Europe taken as a whole. This commercial trouble in American foundries will find a repercussion in Europe. Foundry equipment sales are receding in America, but are increasing in Canada, and it is likely that serious efforts will be made to increase exports generally. British equipment manufacturers, we are pleased to state, are rapidly improving their machinery, and the Dominions and foreign countries are taking much more interest in the commodities they offer.

Foundrymen Visit Manchester University.

On Saturday, November 19, forty members of the Junior Section of the Lancashire Branch of the I.B.F., headed by their President, Mr. T. Makemson, visited the Metallurgical Laboratories of the Manchester University, and were given a very cordial welcome by Professor F. C. Thompson and the staff. After listening to a discourse by Mr. O'Neill on "Strains and Stresses in Castings," illustrated by some interesting experiments, the visitors, in three separate groups, were conducted on a tour of inspection. The time did not allow to be exhaustive, but they made or renewed acquaintance with many things which had relation to their business as foundrymen. Professor Thompson began his explanations with the remark that no attempt had been made to show how castings were made, but specimens, etc., had been brought together which, apart from their interest in other ways, might be of value in suggesting new lines of thought.

Casting in Wax.

The remark had some bearing on the inspection of a number of castings in stearine wax. This is a very useful method, according to Professor Thompson, of seeing how metals solidify, and it can be used with advantage for experimental purposes. It illustrates almost all the phenomena which occur in the casting of metals. Attention was particularly called to the phenomena of crystallisation. A warning was given that steam must not be allowed to come into contact with the wax: if it does the wax absorbs the steam and the crystallisation process is interfered with. The material used is pure stearine wax that ordinarily obtained not being suitable.

Microscopical Research.

Examples were given of the application of microscopical research, to materials used by the foundryman. One was the investigation of moulding sands. Professor Thompson pointed out that in a good moulding sand, the grains varied in size, the small ones partially filling up the interstices between the larger grains. In a sample which the visitors were invited to examine under polarised light, there were big grains, a few of medium size, and quite small stuff. A remark by Mr. S. G. Smith that density might be had at the expense of permeability was assented to by Professor Thompson. There were two extremes, he said. If the grains were of uniform size there would be low density and high permeability to gases. Going to the other extreme, if all the interspaces were filled and choked up with small stuff there was high density and practically no permeability. By compromising it was possible to get reasonable density with reasonable permeability, and that was done in most cases.

The microscopical analysis of coal served a useful purpose in determining the quality of fuel. Coal has four constituents, durain, vitrain, clarain and fusian, and these affect the suitability of the coal for coking and other purposes. One result of research in this direction will be that the foundryman will be able to get coke uniform in quality for his furnace.

Furnaces.

A small furnace designed for surface combustion was stated to be capable of attaining a temperature almost equal to the melting point of platinum. Under proper conditions in such a furnace combustion took place without the production of any flame. Professor Thompson considered this method of combustion had very distinct advantages for very high temperatures. The visitors also watched the process of melting magnesia in an electrical furnace, the temperature of 3,500 deg. C. being attained.

Pyrometers.

The best pyrometers, for very high temperature, Professor Thompson said, were optical. One which was used with the surface-combustion furnace was a modification, a simplification, of the Wanner type. For practical work it was very good. When the eye-piece was looked through there were two fields, one illuminated by the hot body, the other illuminated by an electric lamp supplied by an accumulator. The eye-piece was turned until the two fields of view were equally illuminated and the temperature was then read off on a scale.

In the disappearing filament type of pyrometer, an example of which was examined, an electric current is passed through a filament which shows off against the hot body. When raised to too high a temperature the filament is seen hot against the field illuminated by the hot body; and if the current through the filament is too low, it appears dark: but there is an intermediate stage at which it is the same temperature and the same colour as the body which is being measured. The current which gives that temperature is the measure. Something depends on the constancy of the resistance of the filament.

An explanation was given of the method of operating the thread recorder, which gives automatic records of temperatures. A series of dots were made on a rotating drum, producing a curve. It was possible to take several records on one chart by using dots of different colours.

Fuel Testings.

In the fuel room the methods of determining the flash point of oil, and the viscosity, were shown. The mechanical testing room contained a number of machines for various kinds of tests —impact, tensile, and so forth—and the manner of using them was demonstrated. Elsewhere the visitors saw a wire-drawing process in operation.

At the close of the inspection the visitors were entertained to tea. In proposing a vote of thanks to the Council of the University, to Professor Thompson and to the staff, Mr. Makemson said men who were engaged daily in dealing practically with foundry matters were apt to lose sight of the value of research work. Such a visit as this brought home to them that there was a very close connection between the so-called academic work in the laboratory and the practical problems in the foundry.

Professor Thompson afterwards gave a lecture, illustrated by numerous lantern slides, on "Cast Iron Under the Microscope."

Mr. C. W. Coleman, the well-known foundry engineer, has changed his address from 10, Savoy Street, Strand, to 1, Lancaster Place, Waterloo Bridge, Strand, London, W.C.2.

At the recent meeting of the Honorary Committee of Experts, held at the Connaught Rooms, His Grace the Duke of Northumberland was elected President of the Shipping, Engineering and Machinery Exhibition to be held at Olympia in September, 1929.

Mr. T. G. Allen, proposing the only toast at the annual staff dinner of Messrs. Allen-Liversedge & Company, Limited, held at the Trocadero last Thursday, enhanced his reputation as being amongst the finest after-dinner speakers in the engineering world. About 200 members of the London staff of the firm were present, and with Mr. Harrower's excellent organising ability a really enjoyable evening was spent.

Random Shots.

We are a little inclined to poke fun at ourselves as being the only nation in the world whose mental balance is seriously affected by sport—where else would questions of betting taxes and of totalisators, pictures of the important meets of the season, accounts of Royal personages participating in sporting events, and so forth, receive anything like the public attention that we given them? But it seems that this opinion stands in some need of revision. Have we not, only a day or two since, seen pictures of racing greyhounds on the point of embarkation for China *en route* for a new track at Shanghai? . . . And is it not reported that the French Government is proposing to close the partridge-shooting season because of the scarcity of birds? Does this not show an appreciation of the vital importance of sport such as we ourselves need hardly be ashamed of?

* * *

Nevertheless, there is a good story of "le Sport" as practised on French estates that lend colour to the popular idea of the good Frenchman going forth on the Sabbath morning in full sporting kit, gun and all, to return at the end of a strenuous day with two microscopic birds and a rabbit once in a way. . . . It is told of an English visitor who was taken rabbit-shooting over some preserves near Paris. After some time a rabbit appeared, and the Englishman was about to shoot when his host stopped him, exclaiming: "That is François; we never shoot at François!" The Englishman waited in patience a long time, and at last another bunny hove in sight. He looked inquiringly at his host. "Ah, yes, you may shoot at Paul—we *always* shoot at Paul!"

* * *

Our daily Press, ever alive to a novel idea—or what it conceives to be a novel idea—has been much allured by the recent attempt on the part of Krupps to popularise artificial teeth made of stainless steel, specimens of which were actually on view at the last Leipzic Fair. This has recalled the story of the Wincobank metal worker who broke his expensive and quite indispensable "denture"—nowadays we *never* talk about anything so inelegant as false teeth!—and succeeded in fitting the parts together and casting himself a new set from this pattern in aluminium. We are assured that the substitute set has been in highly satisfactory use ever since!

* * *

A good many people, reading the accounts of the recent disaster in Pittsburgh, must have been surprised to find that there is a quarter of that city known as Manchester. As a matter of fact there is not only a Manchester but a Birmingham as well, both among the very oldest parts of the city. . . . "What's in a name," one is tempted to speculate, for the industrial activities of Pittsburgh are certainly not unworthy to be mentioned in the same breath with those of the English cities aforesaid.

* * *

Both Manchester and Birmingham, Pittsburgh, however, have one great advantage over their English originals, in the possession of a respectable river—and indeed, not merely one river, but three! The town lies on a tongue of land between the Allegheny and the Monongahela rivers, the two joining at this point to form the Ohio, so that the three streams form a "Y." . . . There must be plenty of other towns throughout the world that have grown up in a similar position—its strategic and industrial advantages are obvious—but the only other one that comes to mind at the moment is the little Italian holiday centre of Bellagio, on Lake Como, situated at the point where the three arms of the lake join. It would be hard to find a spot in the world that offers so striking a contrast to Pittsburgh; though Bellagio undoubtedly enjoys great prosperity as a consequence of its geographical position, it can hardly be said to derive from it any advantage that is either industrial or strategic. Maybe in the days when Fort Duquesne was begun at the birthplace of the Ohio, and even at the later date when it was replaced by Fort Pitt, named in honour of a famous English statesman, the spot commanded views whose beauty could rival those of Como.

Marksman.

Sand Milling and Handling.

By H. F. Coggon.

The subject of sand preparation is one of considerable proportions, capable of being side tracked to such an extent that a series of lectures would be necessary to deal with it instead of restricting the time allowed to half-an-hour. It is proposed, therefore, to limit the scope by allowing the main remarks to refer to some illustrations of sand mixing and handling methods.

The mixing of sands has a great influence on the result obtained in the ultimate casting. A sound and clean casting is the result of correct operations prior to and including the pouring of the metal into the mould. The final process or operation is the melting and pouring of the metal. The first process is the selection and correct preparation of the correct materials to contain the molten metal. Therefore, it is obvious how important sand mixing is in the everyday life of the founder. Varying sands in varying proportions, moisture content, amount of

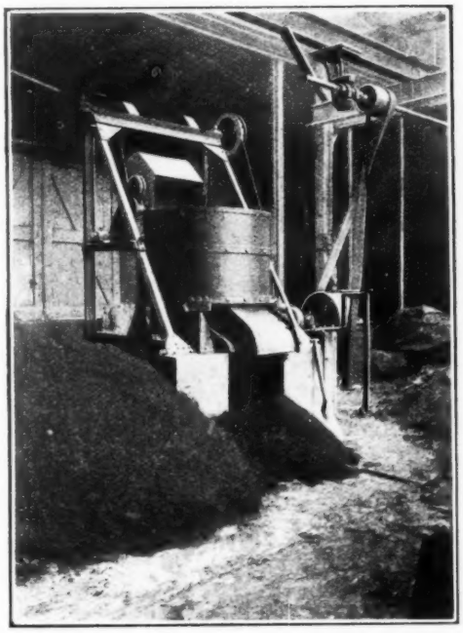

FIG. 1.—THE DISCHARGE SIDE OF THE SAND MILL INSTALLED IN THE WORKS OF MESSRS. J. AND E. HALL, LIMITED, OF DARTFORD.

binder required, tempering and drying of the final structure into which the sand is made, are some of the daily problems.

For sharp or sea-sand mixtures grinding action is usually detrimental, but for sands of natural bond milling is essential, in order to bring out the bond and prepare a material suitable for the mould.

It is the desire of every foundryman to have as homogeneous a mixture as possible, and to be assured of this condition being repeated, not only from mix to mix, but from day to day and week to week. The perfect mix is one which coats uniformly each grain of sand without any excess, so that the points of contact between each grain of sand are held together by the bond, leaving air passages between the various grains. It is, therefore, essential if these conditions are to be met that the mixing should be done in such a way that the minimum amount of binder is used, otherwise during the core-making, handling and drying operations, sections of the core will be heavy and lacking the air spaces necessary for the escape of gases during casting.

Preparation of sand mixtures has of recent years received more attention, both from the every day and practical point of view, and also at the hands of technical and scientific authorities. The British Cast Iron Research Association, under the able control of Mr. Pearce, is tackling this problem in a very astute and progressive manner, and happily they enjoy a close co-operation with the practical foundryman. Undoubtedly sand will play an increasing part in the production of high-class castings in the future.

Liquid Core Binders.

The function of a liquid core binder is to cover each individual grain of sand with a thin film, after being thoroughly mixed and incorporated with the sand—as distinct from a grinding process. Capillary attraction then draws the oil or binder to the point of contact of one grain to another, and as the film of the binder is solidified it cements the grains together. This hardened film or cement is very thin, and as a consequence does not reduce to an appreciable extent the porosity of a core in which a sharp, open sand, free from loam, is used.

One of the urgent needs of the foundrymen, as well as of sand producers, is standardisation of the equipment for the treatment, reclamation and handling of core and moulding sands along sound lines. The problem may appear to be a difficult one, but in no sense impossible, and is sure to be solved as soon as foundrymen generally fully realise the important role which correctly mixed sands play in their business

Moulding sand must be plastic, non-yielding, permeable to gases, capable of resisting high temperatures readily, and after serving its purpose must be easy of disintegration—in other words, the characteristics of moulding sand are grain-size, bond, refractoriness and longevity, which largely governs the property which a sand has for recovering its bond by tempering with water after the drying which occurs during each cast.

On the question of the mixing of sands for foundry purposes, grain-size is a matter of particular importance, seeing that "fineness" means also decreased permeability to gases, and in this connection the general adoption of the small muller type of mixer by the American and Belgium foundrymen, as opposed to the large type heavy mill for sand mixing, is in itself a significant fact.

The Mixing of Sands.

All who have given time and thought to this operation are convinced that a muller type sand mixer is the proper machine in which to blend foundry sands. This is due to the rapid blending action that is effected by the adjustable mullers in this type of plant, in conjunction with the turning over action of the ploughs. A rubbing of the sand mixture develops the maximum bond in facing sand mixtures, so that the amount of new sand added can be reduced by a large percentage. The result is a much better surface on these castings, associated with higher permeability in the sand. A uniformly bonded sand on the face of the mould is obtained, and losses due to poor sand condition reduced to a minimum. Foundrymen are now putting through a muller type machine new sand, with three or four times the amount of heap or floor sand, then adding to their heaps and turning over in the usual manner. This gives a better distribution of the new sand in the heap and eliminates balls or pellets of new sand in the heap. Some foundries mull their heap sand once or twice a week, in order to recondition it and put into proper condition for moulding.

In these times it is, of course, exceedingly important to reduce the cost of foundry sand mixtures, not only by decreasing the amount of new sand used, but also by increasing the quantity of old sand that can be used over again. Sand preparation has only recently received the attention that it deserves. Different methods of moulding mixtures, and of metal for various castings, have occupied the attention of the foundrymen to the exclusion of the sand mixing plant—now considered to be all important.

There is no doubt that ultimately ways and means will be devised to use up all, or at any rate the greater portion, of the old sand for an indefinite period of time in the processes of foundry routine, when foundrymen have more fully learned the true principles of scientific mixing, rebonding of reclaimed sand, and the value of the principles of sand preparation.

It is believed by many practical foundrymen, who have studied the subject, that the most satisfactory means of mixing is by the muller type of machine, provided that the mulling action is so arranged as to avoid destroying the original structure and grain-size of the sand to be treated, but simply incorporates the various ingredients into uniform mixture, at the same time maintaining the original porosity. Hand mixing is definitely a thing of the past—not only on account of the labour conditions prevailing, but also in the reduction of cost by mechanical methods.

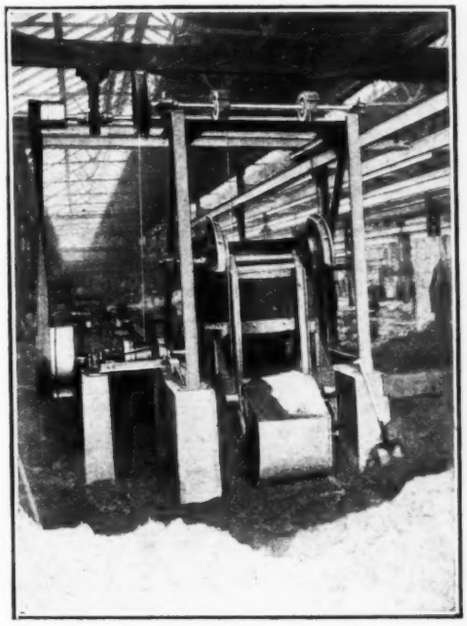

FIG. 2.—SHOWING A MECHANICAL CHARGING ARRANGEMENT ADAPTED TO THE SAND MILL SHOWN IN FIG. 1.

It is important properly to locate the sand treatment department, so that the new sand can be delivered as automatically as is possible into the "mixer," and to take away the resultant mixture quickly and economically, thus securing the maximum capacity from the machine.

In this direction sand conveyor systems and the adaptation of the bucket loader principle is being more generally adopted in this country. Also where one machine is used for both facing and core sand it should be located so that the core mixture and the facing mixture can be transported to wherever they are to be used in the foundry with as little delay and expense as possible. Likewise the return of the old sand to the machine should be kept in mind, so that the expense of so doing will not counteract the advantage of re-using it.

It is also possible with the muller type of mixer to secure a good, efficient and homogeneous distribution of either the binder or other added materials, and so to decrease the amount of these required. Considerable saving of time is effected by the moulder in finishing the mould, which is made from a well mixed sand, which will not so easily fall to pieces and require so much patching. Moreover, the metal will not cut into the

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* A Paper read before the London Branch of the Institute of British Foundrymen, Mr. W. B Lake presiding. The author is Managing Director of Augusts Muffle Furnaces, Limited.

mould because the sand presents a toughened face. With the muller type of machine an adjustment can be made to obviate the grinding action of the mullers upon the pan, and so any danger of grinding action upon the sand grains is eliminated.

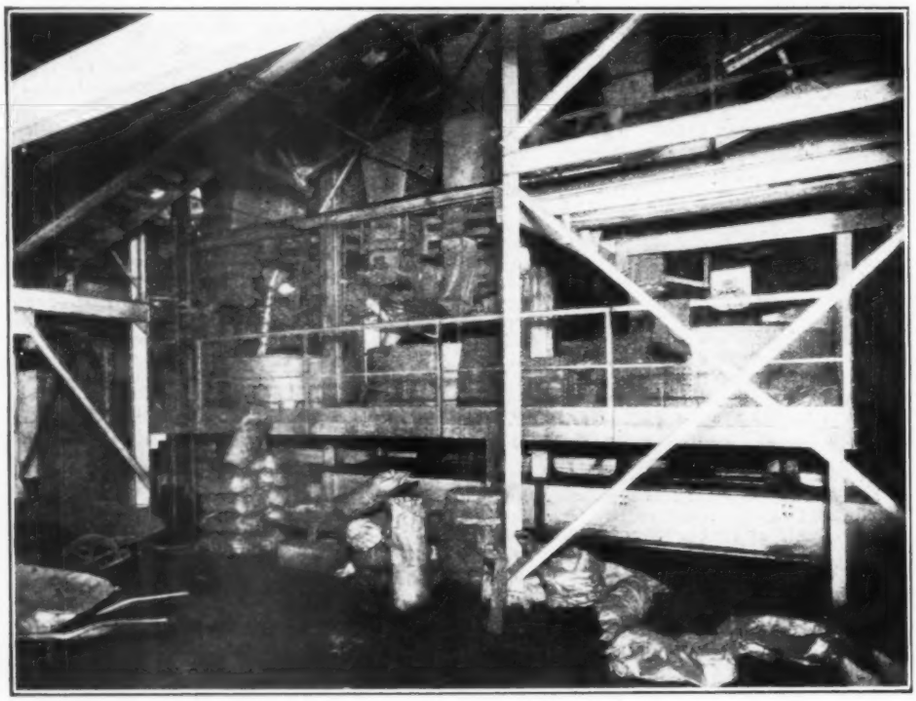


FIG. 3.—SHOWING THREE 6-FT. MILLS IN AN AMERICAN RADIATOR FACTORY.

With reference to the sand-mixing plant installed at Messrs. J. & E. Hall's Works, Dartford, illustrated in Figs. 1 and 2, the following data have been obtained:—

Charge.—3 cwt. of sand ingredients.

Time taken to load mill and mix per charge.—6 minutes.

Rate per hour.—30 cwt. sand.

The following sand mixtures are used:—

(1) *General facing sand for green sand work.*—New sand (Dartford loam), 23; floor sand, 70, and coal dust, 7 per cent. by volume.

(2) *Facing sand (strong) for dry sand moulds.*—New sand (Dartford loam), 75, and old sand, 25 per cent. by volume.

(3) *Facing sand for green sand moulds.*—For 40 to 60 per cent. steel-mix cast iron poured at 1,350 to 1,400 deg. C.: New sand (Dartford loam), 44; old sand, 44, and coal dust, 12 per cent. by volume.

(3) *Facing sand for Perlit iron castings* (heavy sections, with the moulds heated to 350 to 450 deg. C.).—Yorkshire steel maker's sand, 50, and new sand (Dartford loam), 50 per cent. by volume.

Messrs. Barford & Perkins, Limited, Peterborough, have a 6-ft. mill, chiefly used in the mixing of sand for use with power moulding machines, when making green sand castings. The box-parts are shaken out near the mill, adding new sand at the rate of ½ cwt. to the ton of old sand. The sand is milled at the rate of six tons per hour. The loam sand for dry sand moulding is milled at the rate of three tons per hour. Semi-solid and solid compounds for oil sand cores are also mixed as part of the day's work.

Sand Handling.

Mechanicalised sand handling is a project which requires the most careful experience and thought before a decision is made. Each stage in handling proposals must be proved by experiments on a practical scale. The tendency to do the "big thing" initially in many cases has been met with dire results. Small sand-handling units in preference to one larger system should be considered. Smaller units have many advantages over the larger ones, the possible and desirable condition of adjustment to sand condition for particular size and class of casting being of outstanding interest. Further, a seasonal fall in orders and bad trade are factors which favour unit systems. A production of 40 to 60 per cent. does not necessitate overhead expense of operating a 100 per cent. capacity plant. A fault or breakdown inherent in a large system stops the whole foundry; a unit system has all the robust points of flexibility.

A determined effort is being made by the foundry industry in the direction of sand mixing and handling from economic consideration, and progress in the art of founding is forcing them to take every possible advantage of research and invention in order to meet world's competition on a quality and price basis. If one is able to produce a better casting without an advance in production costs the result is a real saving, in so far as the best product secures the highest price.

Mechanicalised invention reclaims waste foundry sand, rebonding of heap sand with clay bond rather than moulding sand. Burned foundry sands are being screened, the fines removed and rebonded for re-use as moulding sand. Routine testing of sand is essential to maintain a standard of grain size, bond and permeability.

It is to be recommended to all foundrymen to investigate and apply one of the various methods for preparation of sands and reclamation of floor or waste sands.

Figs. 3 and 4 show three 6-ft. mixers in a radiator foundry. The capacity of this plant exceeds 100 tons of sand per hour. All the sand is facing sand, which is tempered, and then sea coal added in the mixers. A large amount of synthetic sand is also prepared in this plant to the following proportions:—New moulding sand with 10 per cent. bond, 300; burnt sharp core sand, 1,200, and burnt moulding sand, 300 lbs.

This is blended or prepared in a separate mixer, and added to the bulk of the sand in the following ratio:—Prepared sand, 2,400; synthetic sand, 88, and sea coal, 12 lbs.

Fig. 5 shows a sand-handling system for the preparation of the backing sand in the steel foundry. The double discharge spouts are operated by an air cylinder, thus facilitating loading and discharging of the mixer in 18 seconds. The sand is milled in 55 seconds, and from 50 to 60 tons of sand per hour pass through the plant. A large saving is shown in the operation of this plant, and losses are reduced by the complete control of the temper and bond development in their sand.

Fig. 6 shows the facing sand unit in a steel foundry, consisting of two 8-ft. mixers with hoppers, and also shake out for their heap sand.

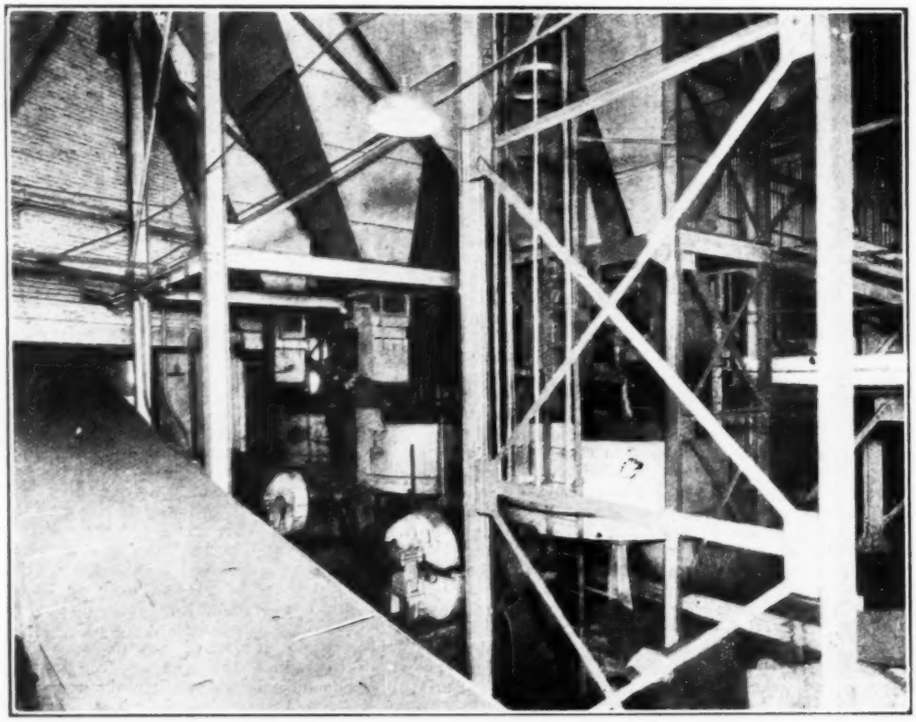


FIG. 4.—SHOWING THE FEEDING OF THE MILLS SHOWN IN FIG. 3.

DISCUSSION.

The BRANCH PRESIDENT (Mr. W. B. Lake) said that the subject appealed to him, particularly because for many years he had tried to reclaim old sand so that less new sand could be used, and to that end his firm had treated it in the manner described by Mr. Coggon. They had reclaimed the sand, removed the fines, and mixed the sand up again with a fresh binder. The experiments had extended over at least 14 or 15 years. He disagreed with Mr. Coggon's opinion that all sand could be used again, because his own experience was that a very large proportion of the sand became broken up into such very fine particles that it was necessary to remove them before the sand could be reclaimed, and then to supply a fresh bond in the form of clay. He endorsed Mr. Coggon's remarks as to the great advantages possessed by the muller system of treating sand over the ordinary grinding pan system, because quite recently his firm had installed a muller machine, which was doing the work formerly carried out by three pans of nearly the same diameter. The aerator used by his firm was an improvement on that shown by Mr. Coggon, because the latter threw the sand down on to the ground, whereas the former was arranged so that it threw the sand up into a truck for transport into the foundry. It would be interesting to know if the steel foundry which Mr. Coggon had illustrated was situated in this country or abroad. Finally, he asked whether the sand from old oil sand cores could be reclaimed and used again for making fresh oil sand cores.

Removal of Fines Essential for Steel Sands.

MR. FRANK RUSSELL thanked Mr. Coggon for his illuminating paper, and particularly for his illustrations, which latter were the clearest and best on this subject that he had yet had the opportunity of seeing. He imagined that the sands dealt with by Mr. Coggon were principally iron foundry sands, because it was his experience that a very much lower proportion of old sand could be used again in a steel foundry than in an iron foundry, and a steel founder who tried to use his sand over and over again without taking out the fines would very soon find that it did not pay. In some foundries he had visited in the United States they were actually taking out the fines and washing the sand before using it again. Those foundries were situated a considerable distance from the source of sand supplies, so that in their case it might have been worth while. Mr. Russell asked if Mr. Coggon had solved the problem of breaking up a very plastic sand which had been milled under heavy rollers, in order to bring out the bond which had subsequently caked. He himself had found that the problem of breaking that sand up, flocculating it, disintegrating it, was one of the most difficult with which he had been faced. Almost every type of disintegrator seemed to choke. The material was so sticky that it impeded the action of whatever plant one used, and an ordinary mixing mill with serrated rollers did not give the desired effect, because the sand leaving the mill carried a large percentage of caked material, which was not well received by the steel founder when he came to use it. He gathered that Mr. Coggon was firmly convinced of the necessity for using heavy rollers in order to bring out the bond. He himself held a similar opinion, after 14 or 15 years' experience of sand milling, but there was a considerable body of opinion to the contrary. Many people held that one should not mill heavily because there was a tendency to break up the grains, and in a number of foundries he had visited he had found the rollers suspended at a distance of perhaps 1-in. or 1½-in. from the pan bottom.

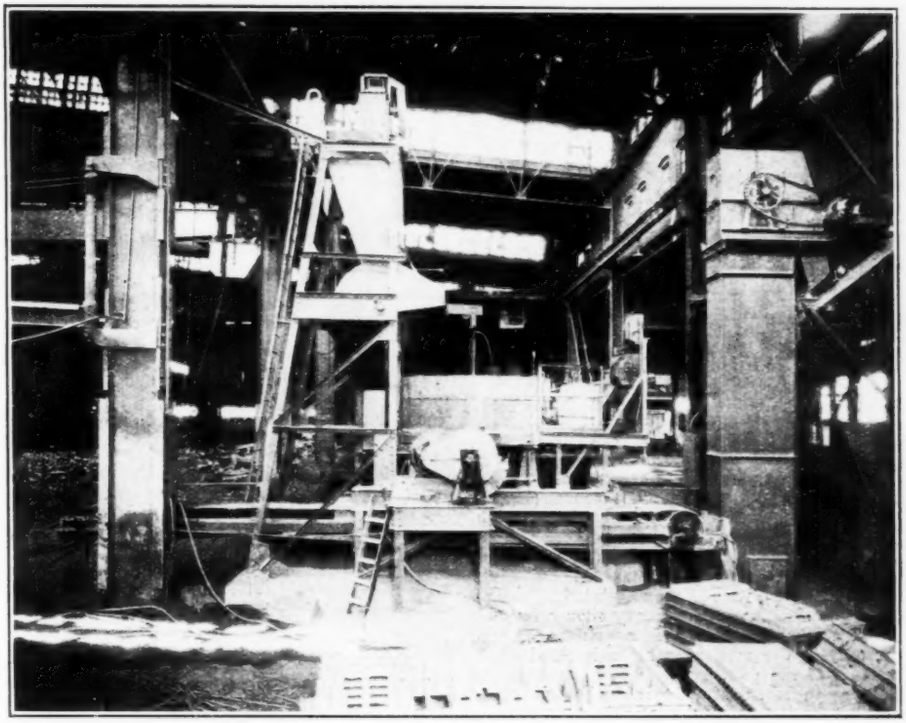


FIG. 5.—SAND HANDLING ARRANGEMENTS FOR THE PRODUCTION OF BACKING SAND IN A STEEL FOUNDRY.

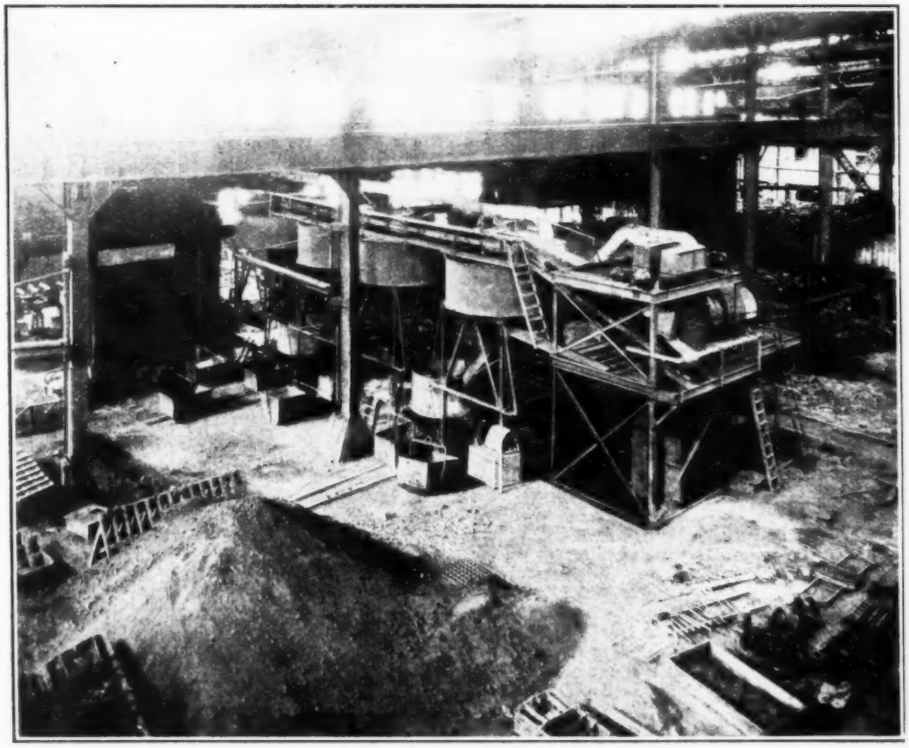


FIG. 6.—ARRANGEMENT FOR THE PREPARATION OF FACING SAND FOR A STEEL FOUNDRY.

Bucket Loaders.

MR. KAIN asked if Mr. Coggon had found that the bucket loading system was altogether without its disadvantages. In using one of the mills described by Mr. Coggon, his firm had found that if the whole charge were put into the mill at once it took roughly 9 or 10 minutes to get the full bond out of the sand, whereas when using a synthetic sand, if they added the clay and a small proportion of sand, and gave that a preliminary milling of about 1½ or 2 minutes, and then added the remainder of the unbonded sand, they had the sand ready for discharging in about 6 minutes, so that there was a saving of 3 minutes on every load of sand.

MR. A. G. W. BAGSHAWE asked what happened when the sand-preparation plant broke down, and said he would like some advice as to the best method of preparing sand by hand. He also asked for a considered opinion as to whether there was an improvement in the value of facing sand if, instead of being prepared immediately before use, it was prepared some days earlier.

It was his opinion that its value did improve with keeping.

Author's Reply.

Mr. Coggon, replying to the discussion, said that the steel foundry he had illustrated was an American foundry, and it was the only instance he had given in his Paper of a foundry situated outside this country. He was unable to say very much about the quantity of old sand that could be recovered in a steel foundry, but it was essential that the fines should be removed. As a matter of fact, he was now investigating that problem, and hoped that in about eight weeks time he would be able to give the Branch President some information on the point. The aerator illustrated could discharge the sand vertically or could throw it a distance of 10 ft. from the machine; the top was adjustable so that the sand could be thrown into a tip, a pit or other receptacle at a distance from the machine. With reference to the heavy muller, he said he knew of no operation in which heavy mullers were not detrimental except when purely grinding operations were required. For mixing, the adjustable light muller was preferable.

Mr. V. C. Faulkner asked the author if he meant that the light muller was adjustable with respect to its height from the pan.

Mr. Coggon replied that its height was adjusted so that it just rubbed the sand on the bottom of the pan, and there was no grinding action, while the ploughs turned it over.

Mr. Faulkner asked what was the distance between the muller and the pan.

Mr. Coggon said it could be regulated according to the charge. With a very heavy charge it could be lifted about 3 in., and if a grinding action were required, the muller could be lowered on to the bottom of the pan.

Replying to Mr. Kain, he said the advantage of a bucket loader was that one could get a definite charge into the mixer every time. The charge did not enter in one mass, but entered gradually as the mill revolved, so that with a bucket loader one should not hold up the loading at all.

As to the possibility of breakdown, mentioned by Mr. Bagshawe, he said that any mechanical plant should be so designed that if a delay occurred it could be very quickly remedied; that could be accomplished. The second sand-mixing scheme that he had illustrated, having an output of 90 tons per day, was so designed that, provided the motor did not give out, any part could be replaced in an hour, and the plant could be operated again. It was his opinion that the value of the sand was improved if it were prepared a day or two before being used.

Old oil-sand cores could be reclaimed and used again if the fines were removed, and that was being done in one steel foundry in Lancashire. Dealing with Mr. Russell's question as to the heavy lumps coming from a mill, he said he rather blamed the mill in that case, because to a large extent it had made the heavy lumps. If there were a quick action with the light mullers and the ploughs, the material was lightened as the mixing was being carried on, and if an aerator were used it broke up the material absolutely fine. Messrs. David Brown, of Huddersfield, had a material similar to that spoken of by Mr. Russell, and had found that with the muller type of machine they did not require an aerator. The material came out perfectly free and fine, and had quite a floury feel.

Vote of Thanks.

Mr. J. W. Gardom, in proposing a vote of thanks to the author, asked whether, in sand-handling systems in which the sand had to travel considerable distances on conveyors, one did not experience a good deal of trouble as the result of the sand drying out by the time it reached the end of its journey. If there were too much heat, all the tempering was lost, so that the advantage was gone, and Mr. Coggon, when acknowledging, pointed out to Mr. Gardom that in systems in which the sand had to travel fair distances on conveyors it was usual to arrange the tempering at various stages of the equipment, so that there was no drying out.

Recent Developments in Welding.

By Stanley Vaughan.

Welding v. Castings.

During the last two years or so the American General Electric Company has, for certain purposes, been using welded parts instead of castings. For example, bases, pedestals and frames for electric motors, generators and converters have been welded together. Especially when only one or two of any particular part is required, welding seems to show quite definite advantages over castings. These have been enumerated in full elsewhere, but it will not be out of place to refer to some of them.

Primarily, the time taken to deliver a fabricated part to the machine shop is much shorter than is the case with a casting, since with the former method there is no time taken up in making patterns and moulds. Also, many castings have to be annealed, whereas with a welded part annealing is unnecessary. In fact, it is stated that welded jobs can be delivered in less time than it takes to make the patterns for the corresponding castings. The cutting out of the pattern making and moulding also reflects itself in the cost of the finished article. Welded parts are also claimed to be stronger than castings, and that the liability of failure due to hidden faults in the metals is very much reduced with welded parts, since it is a comparatively easy matter to obtain uniform mild-steel sheets and plates. Further, when a long, thin member is required, a casting has to be made much heavier than is really necessary owing to the difficulty of casting thin sections.

These are only a few of the advantages put forward in favour of welded parts, but they will serve to show that welding is an operation with which foundrymen will have to reckon with in the future.

The Hydrogen Enveloped Metallic Arc.

The welding operations referred to above are not carried out by ordinary welding methods, and, in fact, it is probable that they would not be possible were it not for the application of a very interesting development in welding technique.

It is well known that joints welded by ordinary methods are liable to be brittle. It has been established that this brittleness is due to the presence of oxides and nitrides in the metal forming the weld, and that as long as the welding operations are carried out in air this state of affairs is very difficult to avoid. To overcome this difficulty welding torches have been designed in which the metallic arc struck between the welding wire or rod and the joint is surrounded by a reducing or neutral gas. Various gases or mixtures of gases may be used for this purpose, but in each case the object is the same, namely, to prevent the formation of metallic oxides and thus produce ductile welds.

The particular gas used is fed along with the welding wire through the nozzle of the welding torch. When the gas used is hydrogen, the arc is surrounded by a hydrogen stream which burns at its outer surface. In addition to producing a ductile weld, the speed of welding is increased, and it is not necessary to bevel the edges of the plates, thus giving a saving in welding wire. For example, welding in hydrogen and using 180 amps. at 60 volts, ¼-in. boiler plates have been welded at the rate of 60 ft. per hour.

Water gas is said to give better results than hydrogen, and has the additional advantages of being inexpensive and easily generated. For portable welding outfits methanol or synthetic wood alcohol has been found useful for supplying the gaseous medium. Methanol is a liquid which boils at 66 deg. C., the vapour decomposing into hydrogen and carbon monoxide at about 700 deg. C. This, therefore, provides a potential source for a mixture of hydrogen and carbon monoxide in a very compact form, since 1 gal. of methanol will give 232 cub. ft. of gas. Also, when stored in the liquid state the hydrogen and carbon monoxide are chemically combined, thus eliminating any risk of carbon monoxide poisoning.

Although in the above no attempt has been made to give a full description of what has been called the hydrogen envelloped arc, it is hoped that it serves its intended purpose of giving an idea of the general principles of this method of welding. It should also be emphasised that the "hydrogen enveloped arc" has passed the experimental stage and is to-day finding extensive use in the United States.

Use of Atomic Hydrogen.

With the welding process described above hydrogen or a hydrogenated atmosphere is used to envelope an electric arc struck between the welding wire and the job. Hydrogen has, however, proved useful for welding purposes in other directions. Dr. Irving Langmuir, of the American General Electric Company, when studying problems in connection with tungsten, found that above a certain temperature molecular hydrogen dissociates into atomic hydrogen with the absorption of a large amount of heat, this heat being liberated again when the atomic hydrogen cools, and recombines to form molecular hydrogen. Starting from this purely scientific basis, use has been made of this property of hydrogen for welding purposes. A stream of hydrogen is blown through an arc struck between two tungsten electrodes, with the result that a flame of atomic hydrogen is produced. This flame is hotter than the oxy-acetylene flame, and has other advantages from the welding point of view, in addition. When used for welding or cutting, the part of the work being heated is surrounded by hydrogen, with the result that oxidation is reduced to a minimum. Gaseous mixtures containing hydrogen have also been used, and although successful they have not proved so satisfactory as hydrogen used in conjunction with a tungsten arc. A carbon arc may also be used, but has the disadvantage that the rate of consumption of the electrodes is very much higher than is the case with tungsten electrodes.

Book Received.

Atlas Metallographus.—By H. Hanemann and A. Schrader, 2 vols. Published by Verlagsbuchhandlung Gebruder Borntraeger, 12a, Ufer Schöneberger, Berlin W.35. Price, for the two volumes, 14.25 renten marks.

These two books have been prepared by Professor Hanemann and one of his assistants from work which has been carried out at the Technical High School at Berlin. They represent a collection of micrographs, 121 in all, of the steel range of iron-carbon alloys. These are set out in eighteen loose plates suitable for framing, and cover the range from electrolytic iron up to 1.48 per cent. carbon steel. We have never yet seen a series of reproductions to equal the illustrations (autotype) in these albums, and we strongly recommend every university and school having a metallurgical department to procure a copy for the use of their students. It is one of those cases where language difficulties scarcely enter into the question, as the short descriptions are translatable by those having only an elementary knowledge of the language. We are convinced that all works handling iron or steel and possessing a laboratory would appreciate and value the use of this album as a means of comparison with their own productions.

Jno. Hy. Andrew & Company, Limited.—The thirty-first annual meeting was held on Tuesday at the company's works, presided over by Mr. H. A. Potts, managing director. The directors' report and statement of accounts were adopted. The chairman gave to the meeting the fullest information as to the difficulties encountered in every direction during the last financial year, which inevitably resulted in a trading loss, fortunately much less than might have been anticipated. He referred in detail to instances of insane home competitioi, also the folly of allowing unrestricted imports from abroad, which, with 26 weeks of miners' strike, coupled with the terrific burden of present taxation, prevented the company paying a dividend.

Notes on Rate of Cooling and Casting Temperature.

(Part 2.)

BY OUR METALLURGICAL CORRESPONDENT.

Since the final constitution in any alloy, and particularly cast iron, depends upon the completeness of the changes, indicated by the critical points, taking place, and since the physical and mechanical properties depend upon this final structure, the influence of the rate of cooling on these changes becomes a very important consideration. The importance of a study of the bearing of this aspect in considerations of the anomalous behaviour of cast iron will be realised.

Rate of Cooling and Grain Size.

Before considering the general aspect of the influence of rate of cooling it is necessary to refer to the other important influence of rate of cooling on the grain size. The observation common to all crystallizing bodies that the slower the rate of cooling the larger the grain size is very familiar. This observation applies to solidifying metals and it will be appreciated that here the grain size is determined at the solidification point, or range, of the particular alloy. Hence the rate of cooling after the solidification cannot have any influence on the grain size, which can only be influenced by the rate of cooling during and before solidification.

The variation in rate of cooling across the section of a cooling mass of liquid metal becomes progressively slower the more nearly the centre of the mass is approached. It is this progressive slowing up of the rate of cooling which is responsible for the coarsening of the grain size towards the centre of the mass, an observation familiar to all foundrymen.

In so far as this applies to cast iron, certain very nice technical considerations arise which form the basis of very interesting speculations. In cast iron the grain size is very often confused with the graphite size, and the real question of grain size has rarely been considered in this connection. One very frequently has the feeling that in those cases in which writers refer to grain size in connection with cast iron, they have in their minds the graphite size. It is somewhat natural that this should be the case. Fractures of cast iron showing varying degrees of coarseness, particularly in the coarser grades, show the graphite flakes visible to the naked eye, a fact which naturally concentrates one's attention on the graphite. It is therefore very important to the foundryman to bear in mind that in the case of cast iron the character of the fracture does not necessarily indicate the character of the grain size. There is no reason why the grain size and the graphite size should go hand in hand. In fact, it is again a matter of careful observation that it is possible to have cases in which large graphite size is associated with small grain size and *vice-versa*. This will be readily understandable on the following grounds. If the view is accepted that the formation of graphite in cast iron takes place subsequent to the solidification period, and certainly this is the view most supported by evidence, then obviously the formation of the graphite must take place subsequent to the formation of the crystal grains and the establishment of the grain size. Under these circumstances it must follow that the formation of graphite takes place within the grains themselves and this, of course, results from an action either involving the dissociation of the free carbide present, or the carbon which exists in the solid solution portion of the mass at this point. It is quite a nice point for investigation as to whether this formation of graphite actually breaks up the grains into smaller grains. This, however, has very little bearing on our present subject, and the above considerations are sufficient to show that the grain size and the graphite size are acted upon independently by the rate of cooling, and at different stages in the cooling down. This is a very important feature, as it is quite conceivable that two cases might exist in which as far as the solidification point and the establishment of the grain size, the rates of cooling have been identical. After this, and before the formation of graphite, the rates of cooling might undergo changes of different values resulting in a difference in graphite size and arrangement. Conditions of this nature might conceivably enter into the explanation of the phenomena of internal chill.

Rate of Cooling and Segregation.

Most commercial alloys, and particularly cast iron, contain small amounts of constituents amongst others, the solubility of which are different and much less in the solid state than in the liquid state. Constituents of this nature show strongly the effect of what is known as primary segregation. If we imagine a mass of solidifying metal in which solidification commences on all the external surfaces simultaneously, a shell of solid metal containing a core of still liquid metal will have formed shortly after the commencement of solidification. Now, if this alloy contains a constituent which is less soluble in the solid metal than in the liquid metal, the first shell of solid metal formed will reject the excess of this constituent over that which is soluble in the solid state. This rejected constituent will be absorbed by the still liquid metal. As this process continues the core of liquid metal becomes smaller in mass, and its quantity of the constituent in question increases until the whole mass is finally solid. Under these circumstances the constituent in question will be excessively concentrated in the interior portions of the mass. This is what is known as primary segregation, and is to some extent influenced by the variation in rate of cooling across the section of the cooling mass. An extremely important aspect of this question, from the point of view of the foundryman, arises out of its connection with dissolved gases. All commercial alloys contain large quantities of dissolved gases. Liquid cast iron is very much like soda water. Even in the solid state it is quite common to find cast iron containing three times its own volume of dissolved gases, chiefly hydrogen, nitrogen and the oxides of carbon. Exactly as in other liquids, the solubility of these gases is greater in the liquid state than in the solid state, and furthermore, the solubility is lessened with increasing temperature. In view of this difference in solubility of the gases in the liquid and solid state they are subject to the effect of primary segregation, exactly as in the manner outlined above. As a result of this the gases become concentrated in the still liquid metal in the centre of the mass. It will be readily appreciated that should the concentration of the gases in the liquid metal reach a point at which this liquid metal becomes saturated the gases will be evolved. This is one of the most powerful causes of blowholes and internal unsoundness in castings.

The steepness of the rate of cooling gradient across the section of a mass of cooling metal exerts a marked influence on the extent of this segregation. Apart entirely from the actual formation of blowholes it is a matter of some speculation as to what extent the concentration of dissolved gases in the central portions of castings influences the general openness of grain and porosity frequently encountered.

Rate of Cooling and Shrinkage.

Exactly as in the case of primary segregation the change in volume from the liquid state results in the concentration of the shrinkage in the internal portions of the solidifying masses of metal. The progressively solidifying metal makes good its shrinkage by the withdrawal of molten metal from that remaining, until finally the whole is solid when the shrinkage is located in the top central portion of the mass. This is known as piping, and is greatly influenced in extent by the steepness of the rate of cooling gradient across the section of the cooling metal. The speculative influence of dissolved gases in increasing or decreasing the extent of this has already been referred to.

The Influence of Casting Temperature.

The influence of casting temperature has usually been considered apart from that of the influence of rate of cooling. Experience and observation has shown from the very early days of the casting industry that the influence of casting temperature on the soundness, grain size, mechanical properties, and constitution of the alloys is very marked. In certain modern investigations attention has been directed to the influence of the temperature attained during melting as distinct from the influence of the casting temperature, and to prevent confusion it is important carefully to distinguish between the two. This distinction has been drawn in several investigations, particularly in relation to non-ferrous alloys. In aluminium alloys it is customary to pay careful attention to the temperature attained during melting quite apart from the casting temperature. This distinction, however, has not been clearly drawn in all investigations.

Generally speaking, in considering the effect of casting temperature, it is the temperature from which the metal commences to cool in the mould in which we are interested. It is, of course, impracticable to measure this in the majority of cases, and for this reason the temperature at which the metal stream enters the mould is usually considered to be the casting temperature.

In many of the investigations on the influence of casting temperature, the above definition strictly applies without any reference whatsoever to the temperature attained during melting. On the other hand, the form taken by many of the experiments on the influence of temperature attained during melting is such that this might justifiably be considered the same thing as casting temperature. It is therefore important carefully to define and distinguish between the two when considering any particular investigation.

In connection with cast iron the casting temperature has been shown to influence the composition, soundness, and the strength properties. With any given composition the combined carbon content tends to increase with increasing casting temperature, and in a like manner the strength properties, as represented by the tensile strength, tend to increase. With decreasing casting temperature the tendency to unsoundness and internal shrinkage defects tends to increase. With the exception of one very important case experiment does not yet appear to have determined the maximum casting temperature, if any, for any given composition of cast iron corresponding to the optimum properties. Piwowarsky in Germany has carried out numbers of experiments into the higher regions of melting temperatures, and in view of the form taken by his experiments these might justly be regarded as casting temperature experiments. Very briefly this investigator found a critical casting or melting temperature above which the condition of the carbon tended to change in one direction, towards the free graphitic condition, and below which in the opposite direction towards the combined condition.

The effect of casting temperature on the grain size of alloys has been studied in connection with certain industrial alloys, e.g., steel, gun-metal and brass. The study of this effect in cast iron has been largely prevented by the difficulty of revealing the grain size for examination. There is no doubt that casting temperature has a similar influence in cast iron to that in any other alloy. The character of the crystals formed, whether of the long needle or prismatic type or of the equiaxed type, is largely influenced by the casting temperature. In cast iron careful measurements of the variation in size of the graphite with the casting temperature has been undertaken, and it has been shown that the highest casting temperature is accompanied by the smallest and thinnest graphite flakes.

The Influence of Casting Temperature on the Rate of Cooling.

The detailed mechanism of the influence of casting temperature in influencing the ultimate

structure and quality of castings is by no means yet thoroughly understood. There can be no doubt, however, that this influence is partially exerted through its influence on the rate of cooling. We have already shown in the first part of these notes that the initial temperature from which cooling was allowed to take place had an influence in lowering the magnitude and position of the thermal arrest points. This influence is identical

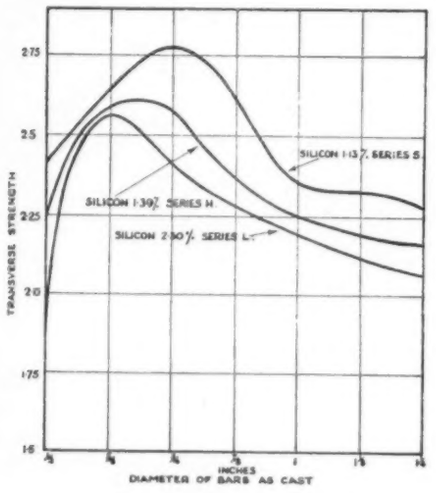


Fig. 1.—Beeny's Results.

with the influence of the increasing of the rate of cooling. It would, therefore, be legitimate to conclude that the increase in the quenching on casting temperature brings about an increase in the rate of cooling. This is, of course, demonstrable by other means, and as a matter of fact is exactly what would be predicted from an examination of this influence from first principles.

Critical Size or Dimension Factor.

The vital influence of both rate of cooling and casting temperature has been elaborated in detail in these notes. Many of these details are familiar to foundrymen, who are generally aware that the properties of their castings are likely to be seriously affected by one or other of these conditions. The complexity of the problem and the difficulties involved in attempting to consider the influence of these two conditions as a whole will be realised from the following short summary of these influences. The rate of cooling and casting temperature jointly influence:—(1) The crystallisation or grain size; (2) the constitution or structure; (3) the composition, including the ratio of

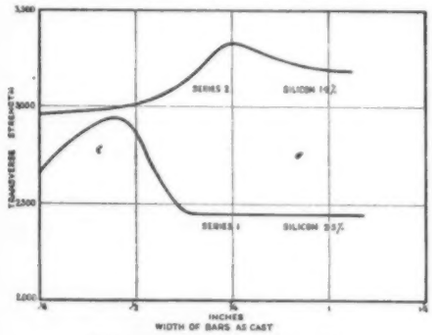


Fig. 2.—Russell's Results.

CC to Gr, and the distribution of other constituents such as sulphur and phosphorus; (4) the distribution of the shrinkage effects; and (5) the evolution of dissolved gases.

In any given casting the material is influenced to a more or less extent across the section of the material, and the problem of vital interest to the foundryman is how the influence of rate of cooling and casting temperature are to be controlled with the object of obtaining the optimum results in his castings. In spite of the apparent complexity of this problem it is found to simplify itself considerably in practice. In what follows the influence of casting temperature *per se* is neglected and the consideration is confined to rate of cooling only.

If we consider a cast iron of a given composition the character of this casting will be influenced by the rate of cooling across its thickness, in all the various directions indicated in our previous considerations. The final character of our material, which we might consider for our purposes to be determined by the ultimate strength, will be influenced in the various directions, some detrimental and others exactly the opposite. Thus the final result will be determined by what might be considered the algebraic sum of all these influences. We should, therefore, expect to find some cooling condition which, other conditions, viz., the chemical composition and casting temperature being maintained constant, would be accompanied in the final material by the optimum characteristics, in this case the ultimate strength. We now have a considerable amount of experimental evidence that this is the case. Beeny (I.B.F., 1924) and Russell (Foundry Trade Journal, September 27, 1923, pages 276-7) have cast series of bars of predetermined composition, under conditions of uniformity in every respect other than the rate of cooling. The rate of cooling has been varied by casting the bars of increasing diameters or increasing thickness. The ultimate strength has been determined on the whole cross-section of the cast bars, thus representing the strength of the whole final structure and condition of the bars resulting from the particular rate of cooling condition. When the strength results are plotted the curves show a well-defined maximum

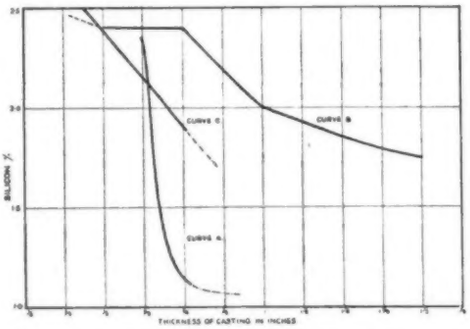


Fig. 3.—Relation between Silicon Contents and Casting Thickness.

corresponding to a certain dimension of bar, or, in other words, a certain rate of cooling condition. These curves are indicated in Figs. 1 and 2, and clearly demonstrate the optimum cooling conditions for each particular composition. Conversely these curves demonstrate the existence of what has been termed, in the sub-heading to this section, the existence of a critical size factor in an iron of a given composition, cast under given conditions, with which the optimum strength properties are obtained. From the foundryman's point of view this is extremely valuable. Under his normal routine conditions the rate of cooling conditions in his castings are only likely to vary seriously due to differences in dimensions. His moulding practice is sufficiently standard to eliminate all but accidental serious variations due to this cause. In a like manner his skilful routine operation of his cupola is likely to provide him with material at a regular casting temperature, except for accidental variations. Under these circumstances the obtaining of the optimum strength results is reduced to the control of the two conditions, (*a*) the critical size factor, and (*b*) the chemical composition.

This, of course, is the general practice on the part of the thinking foundryman, and is by no means new. Several facts, more or less new, in connection with this control system, do emerge from a consideration of the above experiments recorded. From an examination of the curves in Figs. 1 and 2 it will be seen that the maxima occur with increasing silicon contents at lower dimensions. For the purposes of this consideration it will be sufficient to consider the diameter as recorded in Fig. 1 as equivalent to casting thicknesses. This, of course, is hardly strictly true, but under these conditions it will be sufficiently close for an approximation.

If we plot the maxima in Fig. 1 against their respective silicon contents as at A, Fig. 3, we obtain a steep curve indicating the relation between silicon contents and casting thicknesses of material cast under the conditions of the experiment. The curve B, in the same figure, shows the relation between the silicon contents and casting thicknesses for general casting purposes as recommended by Hailstone, and typical of the general text-book relationships between the two conditions. The steepness of curve A is very striking in comparison to B, and indicates the advisability of utilising lower silicon contents, a fact commonly accepted as general for high strength purposes, even in comparatively thin castings.

It is appreciated that the results plotted in A have been obtained on round bars, and that these are hardly applicable to general castings where sharp corners and re-entrant angles are likely to cause the presence of chilled hard places with low silicon contents. The curve C, in Fig. 3, is plotted from the two results given in Fig. 2 by Russell. This takes up a position more or less intermediate between A and B and is probably more typical of ordinary foundry practice, as they are obtained from rectangular section bars. In any event these considerations clearly show that the modern tendency to adopt lower silicon contents, even in general castings, is fully justified.

Catalogue Received.

The Cleaning of Metallic Articles.—This is the title of a 44-page well-illustrated catalogue just received by us from Messrs. J. W. Jackmon and Company, Limited, of Vulcan Works, Blackfriars Road, Manchester. So far as we are aware, this is the first time that the fettling department has had a catalogue solely devoted to its business, and thus it makes a real contribution to foundry trade literature.

The first section is devoted to a description of the numerous types of sand blast and its auxiliary equipment. Sand-blast barrels, the popularity of which is increasing, is now manufactured in three sizes. If transport can be suitably arranged the cabinet type is preferable for small castings to the sand-blast room. These are, generally speaking, gradually giving place to the rotary table sand-blast machine, one type of which is illustrated on page 14, whilst probably the method shown on page 16 will supersede even the larger chambers, as the operator works outside the chamber. The ever-insistent question of economically handling the production of the foundry is seen on page 18, where a reciprocating table sand-blast machine carries long castings right through the chamber and out at the far side, there to be turned over and returned. Again, even in the ordinary cleaning room, a turntable is fitted centrally (Fig 12) or just in front (Fig. 14) in its interior for the rapid handling of its output.

The second section deals with tumbling barrels, and we could not help but feel that a certain section of the "Grinding of castings" order would never have been imposed if the type shown in Fig. 26 had been in general use. It makes slight contact with a water tank and thus eliminates the dust trouble, which the Home Office rightly views with concern. Two types, single and double, of grinding machines are described and illustrated, whilst page 42 is devoted to pneumatic chisels. A section on power git cutters (we wonder why they have never been called "gate" cutters) completes what is undoubtedly the best catalogue which has ever reached us, solely devoted to the cleaning of castings. We confess that we should have liked to see a range of well-designed trestles, to replace some of the crazy contraptions one so often encounters in otherwise well-equipped foundries.

The Influence of the Type of Mould on the Mechanical Properties of Cast Aluminium and its Alloys.

The investigations made by W. Claus and F. Goedritz* should elucidate the influence of the moulding method (chill cast, green sand, dry sand) on some mechanical properties, such as grain size, hardness, tensile strength, and elongation. Besides pure aluminium there were used the American alloy with 8.0 per cent. of copper, and the German alloy with 10.0 per cent. of zinc and 2.0 per cent. of copper, aluminium the remainder. The length of the cast samples was 0.575 in., and their diameter 1.18 in. The chill mould was a round steel block, into which a slightly tapered hole was drilled, the dimensions of which corresponded to that of the sample. The wall thickness which proved most satisfactory was 0.985 in. A greater thickness would accelerate the solidification in such a manner that the air entrapped in the metal during pouring would not be able to escape. A smaller thickness would change the conditions to that met in the green sand mould. The sand moulds had the same wall thickness as the chill mould; a cylinder of sheet metal of 0.039 in. thickness served as flask. The sand moulds after being rammed were allowed to stand until they reached room temperature and were then poured. The metal was melted in a fire-clay crucible in a gas-fired furnace, heated to 770 deg. C. and poured at 700 deg. C. After the samples had cooled the microscopical examination and the Brinell test were made according to Fig. 1. The section for the Brinell test was planed by filing and polished with 000 emery paper. The test was taken with the 10 mm. ball and a load of 500 kg. The hardness figures were calculated according to the following formula:—

$$H = \frac{P}{F} = \frac{P}{\pi D\left(\frac{D}{2} - \sqrt{\frac{D^2}{4} - \frac{d^2}{4}}\right)}$$

P = load in tons; F = area of the spherical cavity in sq. in.: D = diameter of the ball in in.; d = diameter of the imprint in in.

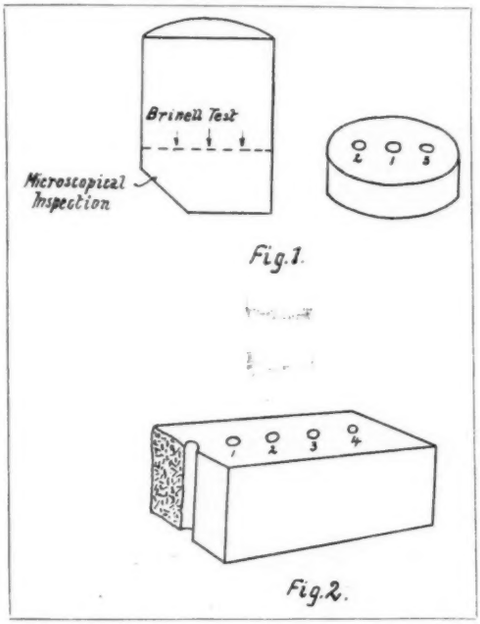


Fig. 1.

Fig. 2.

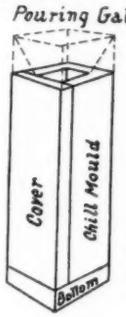


Fig. 3.

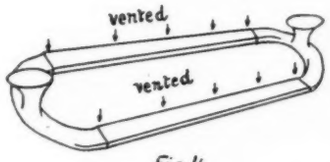


Fig. 4.

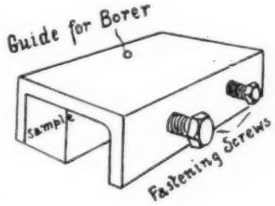


Fig 5.

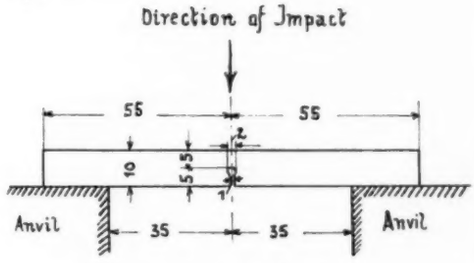


Fig. 6.

The test results are given in Table I. In order to check these results Brinell tests were made on the remaining pieces of the notched bar test samples, as shown in Fig. 2. The results are given in Table II (as the pouring of pure aluminium is only of small practical importance no notched bar test sample of the pure metal was made).

The microscopical inspection showed that the grain size gradually increased from the chill cast to the dry sand samples.

TABLE I.

Test No.	Chill Cast Tons. sq.in.	Green Sand. Tons. sq.in.	Dry Sand. Tons. sq.in.
	Pure aluminium.		
1	17.78	16.2	13.97
2	18.1	16.2	14.3
3	18.1	16.5	14.6
	American alloy.		
1	48.8	46.1	41.8
2	49.2	46.3	41.8
3	48.8	45.4	42.6
	German alloy.		
1	34.3	30.8	29.9
2	34.3	30.8	29.5
2	34.3	31.1	29.5

TABLE II.

Test No.	Chill Cast Tons. sq.in.	Green Sand. Tons. sq.in.	Dry Sand. Tons. sq.in.
	American alloy.		
1	50.8	44.4	41.2
2	48.8	46.3	41.4
3	50.8	44.7	40.0
4	49.2	43.2	40.0
	German alloy.		
1	41.2	34.3	29.2
2	42.6	31.8	30.5
3	41.6	31.8	29.4
4	40.0	31.4	29.9

TABLE III.

Sample No.	Chill Cast.		Green Sand.		Dry Sand.	
	ft. lb.	ft. lb. / sq. in.	ft. lb.	ft. lb. / sq. in.	ft. lb.	ft. lb. / sq. in.
			American alloy			
1	1.628	21.0	1.265	16.35	1.121	14.47
2	1.554	20.0	1.265	16.35	1.121	14.47
3	1.628	21.4	1.265	16.35	1.221	14.47
			German alloy.			
1	6.68	86.3	3.615	46.65	3.00	38.75
2	7.06	90.9	3.69	47.6	2.89	37.35
3	6.68	86.3	3.615	46.65	3.00	38.75

TABLE IV.

Sample No.	Chill Cast.		Green Sand.		Dry Sand.	
	ft. lb.	ft. lb. / sq. in.	ft. lb.	ft. lb. / sq. in.	ft. lb.	ft. lb. / sq. in.
4	8.775	125.3	5.33	76.5	2.645	37.95
5	12.42	178.8	—	—	—	—
6	4.09	58.7	2.13	30.6	—	—

* Giesserei-Zeitung, 1927, No. 18, pp. 516–20.

The influence on the mechanical properties was investigated by the notched bar test. The dimensions of the test bars were 1.26 × 1.26 × 8.66 in. The bars were cast in the following manner:—*Chill Mould.*—Vertically, each bar with a pouring gate of fire clay (Fig. 3). The wall thickness of the mould was 0.591 in. *Sand Moulds.*—Horizontally, together with a tensile test bar, according to Fig. 4.

The molten metal, one-third of which consisted of remelted scrap, was brought to 800 deg. C. and poured at 700 deg. C. After pouring the moulds were allowed to stand for 30 minutes, then the bars were taken out and machined after having stood for 24 hours. The dimensions of the machined samples are seen from Fig. 5. In

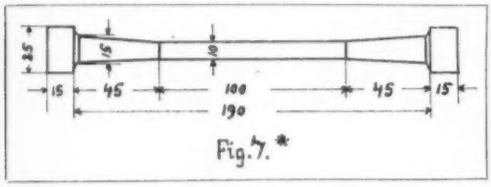


Fig. 7.*

order to ensure perfect uniformity the samples were drilled with the aid of a device seen in Fig. 6; the notch was sawed by hand. The test results given in Table III were won by the following formula:—

$$K = \frac{S}{F} \text{ ft. lb./sq. in.}$$

where S=absorbed energy of impact; F=cross section of sample.

When a certain amount of fresh metal sufficient to fill the mould of one test bar was melted in a small crucible and poured, the test figures differed greatly in the case of the German alloy, as is seen from Table IV (Nos. 4 and 5). This may perhaps be due to the higher loss of zinc met with when large crucibles are used. When the remainder of a large melt (about 5 kg. of metal) was superheated to 850 deg. C. for 25 minutes and then poured, the test sample gave the figures recorded in No. 6, Table IV. In this case the surface of the bath showed a thick layer of ZnO. To check the results of the notched bar tests some tensile tests were made; the dimensions of the test bars are seen from Fig. 7; the test results are recorded in Table V.

Table V.

Sample No.	Chill Cast.		Wet Cast.		Dry Cast.	
	Ultimate tensile strength. Tons. sq. in.	Elongation. Per cent.	Ultimate tensile strength. Tons. sq. in.	Elongation. Per cent.	Ultimate tensile strength. Tons. sq. in.	Elongation. Per cent.
			American alloy.			
1	14.6	3.0	10.48	1.5	8.26	1.4
2	13.64	2.7	10.8	1.2	8.7	0.9
			German alloy.			
1	12.31	4.2	10.28	3.0	9.53	2.5

The Continental Steel Trust.

The next meeting of the Continental Steel Trust has been fixed for December 9, when the quotas for the ensuing quarter will be settled. It is understood that Germany, Belgium and Luxemburg, which have hitherto exceeded their output allotments, will urge the maintenance of the present rate of production. On the other hand, the interests of France, who has never yet reached her quota, are said to lie in the direction of a reduction in the quotas, that country having been 10 per cent. behind her allotment. In German circles it is anticipated that the present quotas will be continued. As regards the formation of selling syndicates for semi-finished material and shapes, it is not known whether the demands made by the Belgian works for an increase in the quotas offered to them have been conceded. In German quarters there is no disposition to go further than to cede the 20,000 tons to the Belgians offered to them at the last Luxemburg meeting.

The Polish Ministry of Commerce have convened a conference at Warsaw of representatives of the iron and steel industry of Congress Poland and Upper Silesia for the purpose of discussing problems in the industry.

Is There a Tin Shortage?

By the Right Hon. William Graham, LL.D., M.P., late Financial Secretary to the Treasury.

The Consumers Interests.

The present controversy regarding the proposed scheme for stabilising the world price of tin directs attention to a commodity of great economic importance.

Britain probably controls 60 per cent. of the world's production; the United States overtakes an even bigger percentage of the world's consumption. Many authorities suggest that tin is in short supply.

Of its importance in daily life the illustrations are abundant. The large development of motor-car manufacture recalls that at least five pounds of tin is used in the manufacture of every vehicle; twenty-five to thirty pounds in the manufacture of every aeroplane; while the demand of the commodity for the enormous trade in tinned goods requires little or no emphasis to-day. Demand is apparently increasing; and so far no substitutes for tin appear to be in view.

In Great Britain the leading elements in recent analysis may be conveniently summarised. In 1926, perhaps mainly because of the prolonged coal stoppage, home deliveries of tin were smaller on the year by more than 4,000 tons. The visible supply was regarded as having diminished on the year by 1,300 tons to 15,817 tons, according to returns compiled by one of the competent authorities.

American consumption of more than 78,000 tons compared with the 76,475 and 64,160 tons respectively in the two preceding years was certainly impressive; at that rate America consumed nearly 6,500 tons per month.

British analysis in the early part of the present year did not discern any set-back in American consumption; there are probably greater fears on that point to-day. At the time of that review American tin plate mills were operating at the fullest capacity in their history, with an output of, roughly, thirty-four million basis boxes per annum; the outlet for tin in the United Kingdom was then regarded as likely to show a fair recovery.

But the fluctuations in price encouraged in some quarters the demand for control and price regulation. In 1926, for example, the extreme points for cash standard tin were £321 2s. 6d. and £261 7s. 6d., or an average of £291 3s. per ton.

One of the latest reviews, dealing with the first nine months of 1927, suggests that the set-back in the American deliveries amounted to 3,160 tons. Attention was again directed to what were regarded as the persistently depressing tactics of certain groups interested in the commodity.

This visible supply covers a wide field; it means more than is usually signified by the term "stocks"; there is included tin in transit, which is not available for consumption.

It is thought that the total consumption of tin varies between 11,000 and 12,000 tons monthly. The stocks available for consumers in 1926 and 1927 were regarded as equal to approximately ten days' consumption, as compared with a month's supply at the beginning of 1923.

This change, the importance of which is obvious in the light of current discussion, is supplemented by the fact that at the end of 1926 warehouse stocks—in this connection excluding tin landing which was not strictly available for consumption—amounted to 2,641 tons; at the end of July, 1927, the figure was 1,652 tons, or less than one week's consumption, and consumers of tin are entirely dependent on supplies coming forward regularly from the countries of production.

It is thus plain that owing to the development of certain classes of manufacture there is a largely increased demand for tin; on the other hand, the problem of available supplies increases.

For these and other reasons the position of the commodity is one of exceptional interest in existing conditions; and it is important that the public, as direct and indirect consumers, should immediately avail themselves of all accurate information on the subject.

I.B.F. Branch Presidents.

No. 6—Wales and Monmouth Section.

Mr. Ben Hird is a Yorkshireman, having been born at Shipley, where he served his apprenticeship with J. Parkinson & Sons, machine tool manufacturers. He went south to Maldon, in Essex, in 1908 to organise the machine-moulding department of E. H. Bentall, agricultural implement makers. In 1914 he went to Birmingham and

Mr. Ben Hird.
(President of the Wales and Monmouth Section of the I.B.F.)

joined Mr. Percy Pritchard in the early days of the Midland Motor Cylinder Company. In 1915 he was appointed foundry foreman to Barford & Perkins, Limited, of Peterborough. Here, having been a member of the Institute of British Foundrymen since 1912, he started a local section, and also conducted foundry classes at the local technical school. In 1919 he was appointed foundry manager to Allen & Simmonds, of Reading, where he equipped a new foundry and pattern shop for the quantity production of motor castings. Since 1923, Mr. Hird has been foundry manager to Guest, Keen & Nettlefolds at the Cwnbran Works, near Newport, Mon. During the last four years these foundries have been entirely re-equipped with modern plant for the production of sleepers, chairs, brake blocks, and standard wagon castings and jobbing work. Mr. Hird is the author of numerous papers on various aspects of foundry practice, and recently has devoted his energies on the evolution of gas from chills. He was one of the founders of the Wales and Monmouth Branch, over which he now presides.

Canadian Rails for South America.—After having secured orders for rails for Jamaica and British India, the Dominion Iron and Steel Company has now obtained again in public competition an order for about 25,000 tons of rails for the Chilean Government lines.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Britain's Largest Aluminium Casting.

To the Editor of the FOUNDRY TRADE JOURNAL.

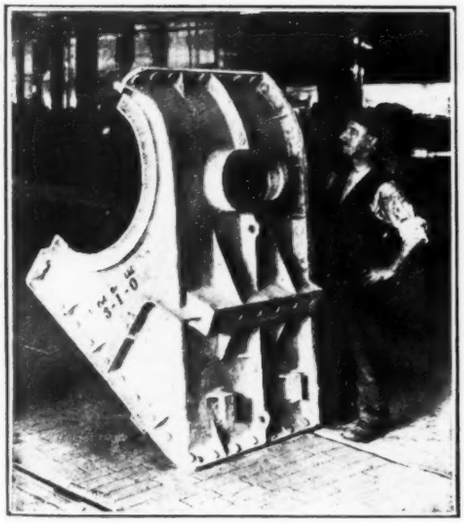
SIR,—Referring to your note on "Britain's Largest Aluminium Casting," which appeared in the issue of November 3 of your valued paper, I do not contest that the casting mentioned may or may not be the largest ever made in Great Britain, but am well aware that castings of greatly larger size have been made in Italy.

I enclose a photograph showing the production of aluminium and aluminium alloy castings currently made by the foundry of the S.A. Isotta Fraschini di Milano (well known motor-car manufacturers). At the left side you will notice two castings for electrical machinery both surpassing two metres (7 ft.) in diameter. The first one at the left was made of Silumin, and has a diameter of 2.30 metres and weighs only 65 kg. (144 lbs.). The large casting in the centre, of 4.815 metres diameter (16 ft.) is also a very interesting specimen of the possibilities of aluminium casting. It is made of four pieces, each one eclipsing in size the casting reproduced in your paper, and has been regularly produced in aluminium (weight 200 kg.) and Elektron (weight 125 kg.). The exceptional production of this foundry was well appreciated in the Paris Foundry Exhibition, where the Isotta Fraschini was awarded the Grand Prix, and I think that the photograph will interest your readers.—Yours, etc.,

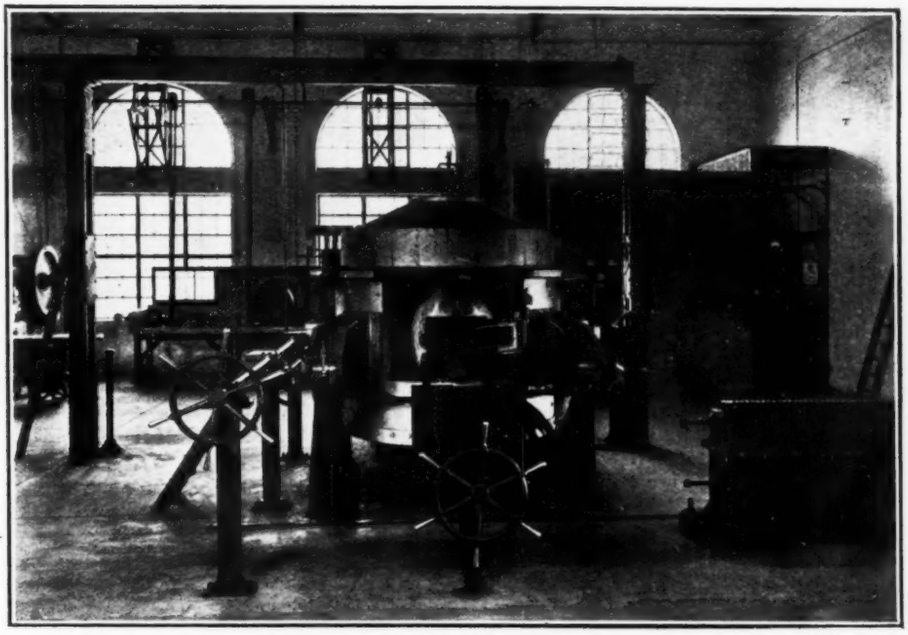
ING. GIACOMO BARGELLESI,
M.Inst.Brit.F.

Milano, Italy,
via Tantardini NB.,
November 19, 1927.

THE FRASCHINI EXHIBIT OF LARGE ALUMINIUM CASTINGS AT THE PARIS CONFERENCE.



A LARGE MARINE CASTING IN ALUMINIUM, BY SIR W. G. ARMSTRONG, WHITWORTH & COMPANY.



ELECTRIC ALUMINIUM MELTING FURNACE.

Britain's Largest Aluminium Casting.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—We notice in the FOUNDRY TRADE JOURNAL of November 3, 1927, a letter and photograph on the subject of large aluminium castings, and we enclose a photograph of a marine casting in aluminium alloy, recently made in our foundry, which we think might be of interest to your readers. The casting weighs 3¼ cwts.—Yours, etc.,

For SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED,
C. F. HITCHINS,
General Manager Controlling Sales.

Elswick Works, Newcastle-upon-Tyne,
November 18, 1927.

Foundry Query.

Melting Aluminium Alloys.

We notice on page 94 of your issue of November 3 a query signed by "Light Alloy Founder," in which your correspondent inquires concerning the best type of electric furnace for melting aluminium alloys.

We have installed furnaces both for the refining of aluminium pig and also for melting aluminium and its alloys for the production of automobile castings and also for rolling mill purposes, and we should be only too pleased to give your inquirer all the information in our possession. There are many of these furnaces, which are of our "Resistance-Radiation" type, in regular commercial operation giving complete satisfaction. Precise control of furnace temperature and atmosphere is easily obtainable, and absolute uniformity of treatment can be ensured with the result that any previous operation may be repeated exactly.

Of course, one of the principal advantages of electric furnaces for this purpose is the elimination of oxidation. The oxide loss is reduced by the electric furnace to that contained in the metal when charged. Overheating of the metal is impossible.

For the automobile trade these furnaces offer special advantages in that they ensure sound castings.

VERDON O. CUTTS.

Town Hall Chambers,
87, Fargate, Sheffield.

Methods of Measuring Contraction.

By H. C. Dews.*

The changes in volume which occur in a metal passing from the temperature of the molten liquid to that of the solid casting are responsible for the major portion of the difficulties encountered by foundrymen who need to produce sound castings. This has been realised by several generations of foundrymen who have slowly built up an elaborate moulding technique designed to prevent porosity in castings. They have lacked the facilities and the knowledge to apply scientific investigation to their problems and whatever artifice they have ventured has resulted from empirical tests. Lately a few serious attempts have been made to study volume change on a scientific basis, and a certain amount of physical data to guide foundry practice has been provided. It is doubtful, however, if there are many foundrymen who are ready to admit that any of their success is due to this painstaking scientific work. It is not the purpose of this article to elaborate this point further than merely to call attention to its dual aspect. Whereas the scientific workers very frequently blame the foundryman's ability to assimilate their abstruse conclusions, the foundrymen are equally vehement in their denunciation of most "foundry science."

Whatever point of view one adopts towards technical work in the foundry anyone who gives serious thought to the subject must agree that the present time calls for a different treatment of foundry problems than has been practised in the past. The cost of sound castings, which engineers now so ruthlessly demand must be, under the old system, in time and temper alone, prodigious, and in this strenuous industrial generation has become unsupportable. Shorter and safer roads to success must be found. One of the first aids to this end is undoubtedly a proper understanding of volume changes, and the many gaps in our knowledge should suggest a very profitable field of research to individuals and associations supported by our industry for its guidance. This present résumé is intended to illustrate the work which has been already attempted.

In the foundryman's vocabulary "shrinkage" and "contraction," "pulling" and "drawing" have had a variety of shades of meaning, and it is only recently that the real sequence of volume change during the making of a casting has been understood.

When metal is poured into a mould it is at a certain temperature above its freezing point. As the liquid cools it undergoes a gradual change—usually a diminution—in volume. When it reaches its freezing point the liquid solidifies with a new and sudden change in volume. This also is often a diminution in volume sometimes up to as much as five or six per cent., but it may be occasionally an expansion. Finally, as the now solid metal cools to normal temperatures it suffers another gradual change in volume—again more often than not a contraction. These three series of volume changes are shown graphically in Fig. 1, which refers to two common metals—copper and bismuth. The volume change in the liquid is shown by the portion of the curve marked L. The sudden change on freezing is shown by that part marked F, and it can be seen that copper contracts to the extent of 4 per cent. of its volume and bismuth expands by 3½ per cent. of its volume on freezing. In each case the solid metal contracts on further cooling, as shown by the portion of the curve marked S.

The writer has previously called attention to the important bearing of each phase of the volume change on the production of a sound casting and it is necessary that the exact course of these curves should be known for every alloy the foundryman is called upon to cast.

A large group of investigators have confined their attention to the volume change which takes place in the solid casting, and their results have been very useful to metallurgists and pattern-makers. Unfortunately these results have also been misinterpreted and taken to cover the whole range of volume change. From the most notable of these researches one can single out the tests devised by W. J. Keep * and Professor T. Turner,† both of which were applied originally to cast iron. In both of these tests metal is cast into a mould provided with a device to record change in length of the test piece. The change in length is then assumed to be proportional to the change in volume. In both cases the recording arrangement only comes into operation when certain connectors in the mould have been gripped by solid metal. By that time, of course, the volume change in the liquid and the volume change on freezing have both been passed.

Another group of investigators working on volume changes in metal concentrated their attention on determining the density of the liquid metal at some haphazard and uncertain temperature above its freezing point. The difference between this figure and the density at ordinary temperatures gives the alteration in weight of a unit volume of metal. From this can be obtained the change in volume taking place between the two temperatures. Such figures have been wrongly labelled as volume change on freezing. Actually the figures cover the volume change in the liquid from the temperature of the density determination to the freezing point, the volume change on freezing and also the volume change in the solid from the freezing point to ordinary temperatures. The sum, in fact, of three values.

The first serious work on the determination of the density of liquid metal was published by R. Mallet in 1874,‡ using cast iron. The choice of

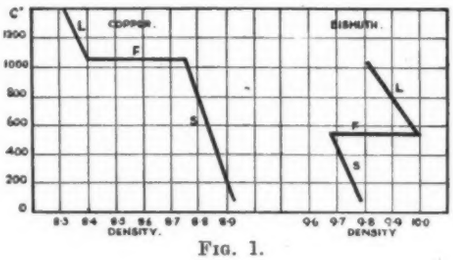


FIG. 1.

cast iron at that date was natural, but it was unfortunate from our present point of view. Solid cast iron, on cooling, undergoes certain microstructural changes which involve volume changes, and these variations are very much dependent on cooling conditions. This complication has fogged many determinations of the volume change on freezing, and has led to discussions even on whether cast iron shrinks or expands on freezing. Mallet's method was just to fill a container, whose volume was known, with liquid metal. After cooling the ingot was weighed and the density of the metal at the temperature of filling the container was thus calculated. A similar method has been followed by several workers since, who have modified the size and shape of the container without materially affecting the principle of the method. The main objection to these experiments is that if the container is filled with metal very near its freezing point some will freeze during the filling, and its volume change on freezing will be made good before the mould is full. On the other hand, if sufficiently hot metal is used entirely to fill the mould with liquid, some of the volume change due to the liquid range will be included in the final result. As already mentioned, in any case, the volume change of the solid metal is included with the volume change on freezing.

An ingenious, if somewhat clumsy, method, recently used by J. Longden,§ offers by suitable refinement promise of valuable results. Longden experimented with cast iron, which for reasons mentioned above make it difficult from his results to draw any broad conclusions as to the applicability of his method to other metals and alloys. His procedure was to make two moulds exactly similar, except that one had a riser in the orthodox way and the other a channel at the top which drained away all the metal except that which just filled the mould. The intention was to make two castings, one of which would be fed solid to the full size of the mould and the other allowed to shrink from the mould size without any feeding. The difference in weight was taken to represent the volume change on freezing. One of the objections brought against Mallet's and similar work seems to apply here, in that some of the liquid volume change is included in the result. Longden's method, however, differs from the others in that the solid volume change is practically eliminated.

A few attempts have been made to measure the density of liquid metal by noting the pressure exerted by a column of known height and cross-section. This principle has lately been used by C. Benedicks* and his co-workers, who have devised an apparatus with great care and patience. Two U-tubes were connected together to form a closed circuit. In one U-tube was mercury and in the other liquid metal. Pressure by an inert gas was applied equally to one arm of each U-tube. The density of the liquid metal was then given by the ratio of the difference in level of the liquids in each U-tube times the density of mercury. The practical apparatus, as developed, was used to determine the density of steel, which on account of its high melting point imposes a very severe test on the method. The results obtained, however, bear the impression of reliability, and suggest that the method is worthy of greater interest.

An entirely different method of determining the density of liquid metal was first applied by Roberts-Austin and T. Wrightson† in 1881, who measured the loss in weight of a "sinker" suspended in the molten metal. Several workers have followed the method, using sinkers of quartz, quartz coated with gold, tungsten and alundum. Many density determinations of liquid metal of low melting point have, by these means, been successfully carried out, but no modern work has been published on the application of the method to higher melting point alloys, owing apparently to the serious experimental difficulties.

Attention has drifted to an inversion of the "sinker" method in which the molten metal is suspended in a neutral liquid. The work of H. Endo, in Japan, is of outstanding importance. Endo's‡ apparatus consists of a special balance from one arm of which is suspended a small crucible containing the molten metal. This is immersed in a suitable liquid such as paraffin for low temperatures and fused salts for high temperatures, and the loss in apparent weight of the specimen is determined over a range of temperature as the metal cools and solidifies. Change in density curves are thus obtained, from which can be obtained the volume change on freezing. This appears to be the only reliable method so far published which gives the true value of the volume change on freezing free from either of the other volume changes, and as such is an outstanding achievement, since of all the three ranges of volume change the one which occurs as the metal is freezing is the most important to the foundryman. Most of the workers mentioned above have recognised the importance of this value, but have apparently, in most cases, ignored the entire existence of the liquid and solid volume changes. Now that the real sequence of volume changes is being more clearly understood there is reason to look forward to more reliable data, and when this is forthcoming and assimilated by foundrymen the production of sound castings may assume a simpler aspect.

SIR HUGH BELL, BART., has been re-elected chairman of the Tees Conservancy Commission.

---

* The author is metallurgist to Messrs. J. Dewrance & Company, Limited.

* Cast Iron, 1909.
† Journal Iron and Steel Institute, 1906, I. 48.
‡ Proc. Roy. Socy., vol. xiii., page 222.
§ Proc. I.B.F. vol. xviii, page 573.

* C. Benedicks, D. W. Berlin and G. Phragmen, Carn. Sch. Memb., 1924–13–129.
† Phil. Mag., vol. xl and vol. xlii.
‡ Journ. Inst. Met., 1923, xxx, page 133.

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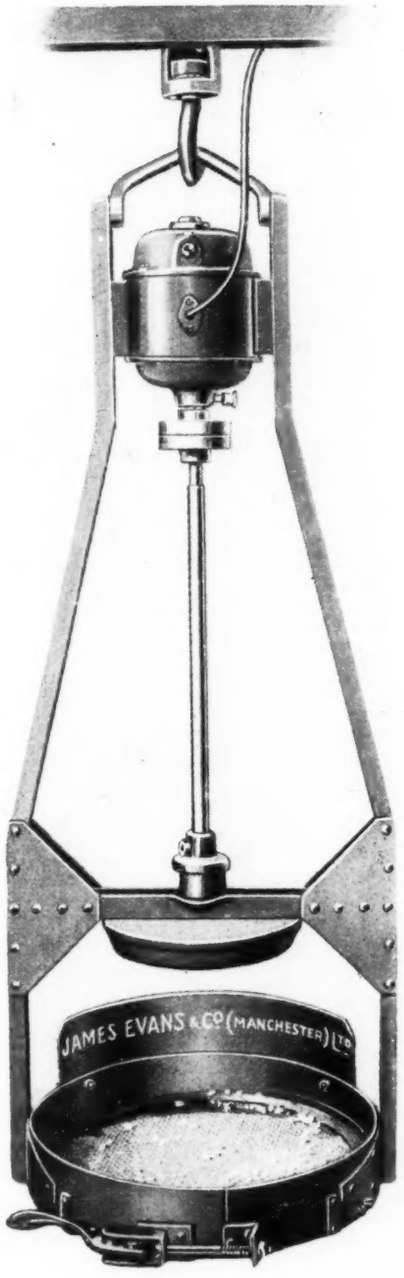

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Characteristics of Some Steel Moulding and Core Sand Materials.*

By E. R. Young,† Detroit, Mich.

Introduction.

Most steel foundry facing sands are ordinarily synthetic mixtures, with a nearly pure silica sand as a base. Accordingly, they correspond more closely to the core sand mixtures made up from sharp sand used in iron and non-ferrous foundries than they do to the natural bonded moulding sands. Therefore, a number of the generalisations made in foundry literature regarding moulding sand do not apply to steel foundry conditions. This distinction is familiar to all steel foundrymen, but is not so clear to all the investigators of foundry sand and may be worth emphasising for a moment in introducing this subject. For this same reason, *i.e.*, that steel foundry moulding and core sands are both synthetic mixtures, it is convenient to include both in a discussion of the ingredients of these mixtures.

In conducting experimental work seeking cleaner and easier cleaning castings, the writer has come to think that good quality steel foundry materials are pretty nearly adequate to the job and that what we need is a better application of them. He has also been impressed by the fact that the shop men know quite accurately how to produce a given result on a definite, difficult casting when studied as an individual problem and that the difficulties attributable to sand facing or cores are frequently the results of a general practice which may not be so well thought out or which may misapply the material to a specific job.

A Survey of Materials and Practice.

In this Paper the writer has attempted to present a survey of the common materials, their behaviour described in shop terms, what is expected of them, and what is obtained from them, with the thought that it might present the basis for a common discussion of theories and observations and might lead to something worth while.

The data given in this Paper are therefore not a report of research and of tests to determine new or unknown properties, but are tabulations of the known properties of some of the common materials used in making up the synthetic moulding and core sand mixtures. Table I lists seven materials exclusive of silica sand, the relative green and dry bond of each, relative cost of each kind of bond, the nature of the material, as mineral, vegetable, volatile, combustible, etc., and the melting points of the solids when definite, temperature at which dry bond is destroyed, condition after baking or drying as to hardness, behaviour under heat as to hardness, and nature or rapidity of collapse, tendency to absorb moisture, effect on refractoriness of the sand, effect on permeability of sand, effect on ease of removal of sand and casting surface resulting.

Because of the difference of opinion as to the best method of determining green and dry bond, and the necessity of standardising all the factors involved, there has been no attempt to give absolute values for these properties, but to indicate their relative values.

Regarding the data on nature of materials, there has been no attempt to go deeply into the physical or chemical properties of the materials, but only to give a description of them in simple terms, as of mineral or vegetable origin, combustible or incombustible and the per cent. which forms gas, per cent. which forms ash, together with the significant melting points. This may seem merely the repetition of commonly known facts, but the object is to try to accurately describe from the shop viewpoint the actual behaviour of the materials in the preparation of moulds and cores and the behaviour when subjected to the action of molten metal in pouring. So this table lists only these simple characteristics and goes more into detail regarding history of the material in the foundry.

To pass judgment on the behaviour of materials and the results secured with them, it is necessary to designate as closely as possible the type and cause of defects attributed to materials, as erosion or cutting, fusion, penetration, spalling or burning down, etc.

When foundrymen refer to refractoriness and fusibility, is there actually any fusion of good materials or is it a matter of penetration or erosion perhaps due to lack of baked bond? Why is it that when the sand has a fusion point well above the pouring temperature of the steel, the fireclay has a fusion point above the pouring temperature and the finished facing mix from these two materials also has the same high fusion point there is still sand "burning in"? Is there actual local fusion or is there erosion or cutting of the sand surface and penetration of the metal into the surface layer of the sand for that reason? If so, what is the relation of the cutting to the amount and durability of the dry sand bond or baked strength of the mould or core, and what is the relation to the fineness or closeness of the sand surface?

Some of these questions are discussed briefly following the explanatory remarks regarding the data of Table I.

Description and Source of Data Tabulated.

Green Bond.—The green bond figures are based on data accumulated from shop tests. The relative values for amount of green bond are based on the bond of a 1 to 10 mixture by weight of the material with dried Ottawa sand, mixed by hand with the moisture content which gives highest green bond for that material. The bond of a good grade Ohio fireclay under these conditions (Lindstrom test* with A. F. A. type bar—approximately 115 grams A. F. A. bond) is taken as a base and given unit value. The bond of each of the other materials was reduced to the same binder to sand ratio when necessary and referred to the base value given for fireclay.

The green bond of the materials having a value of about half is very close to the green bond of the moistened sand alone, so it is doubtful if these materials add any effective green bond.

The green bond of the materials used for dry strength—strictly core binders—is not considered significant at the moisture content, 6 to 8 per cent., used for core sands.

The relative cost of green bond is based on the cost of bond secured from 1 lb. of fireclay which is given unit value.

Dry Bond.—The dry bond figures are given with considerable hesitancy. Relative figures giving the range or order of magnitude are not so innocent as first appears, as one must have a definite value which one can stand by to determine the

Table I.—*Characteristics of Materials.*

Material.	Fireclay.	Silica fluor.	Cereal binder.	Dextrine.	Molasses.	Resin.	Linseed oil.
Nature	Mineral, 5 to 10 per cent. volatile, incombustible.	Mineral, non-volatile, incombustible.	Vegetable, some volatile, 99 per cent. combustible.	Vegetable, some volatile, 99 per cent. combustible.	Vegetable, 30 to 35 per cent. volatile; 95 per cent. volatile, and combustible, 5 per cent. ash.	Vegetable, 95 per cent. volatile, and combustible, 5 per cent. ash.	Vegetable, 95 per cent. volatile, and combustible.
Melting Point in Deg. C. ..	1,650 to 1,700	1,700	Decomposes.	Decomposes.	Liquid.	Softens at 40 to 45	Liquid.
Temperature destroyed Deg. C.*	480 to 535	—	280 to 315	265 to 315	205 to 260	315 to 370	315 to 370
Effect on refractoriness of of sand	Lowers.	None.	Little.	Little.	Little (ash may lower it).	Little (ash may lower it).	Little.
Effect on permeability of sand	Lowers.	Lowers.	Lowers.	Lowers.	Little.	Little.	Little.
Condition after drying	Fairly hard.	Very hard.	Fairly hard.	Fairly hard, softer in centre.	Hard, softer in centre.	Hard.	Very hard.
Tendency to absorb moisture	Some.	Some.	Some.	Strong.	Strong.	Very little.	Little.
Behaviour of bond — Hardness before destruction	Hard.	Hard.	Softens slightly.	Softens slightly.	Softens.	Softens.	Hard.
Behaviour of bond — Nature of collapse	Slow.	Slow.	Gradual.	Gradual.	Gradual.	Gradual.	Rapid.
Ease of removal	Hard.	Hard.	Good.	Good.	Good.	Good.	Very good.
Resultant casting surface ..	Fair.	Good.	Fair.	Fair.	Fair.	Fair.	Good.

* Refers to pouring, not baking, conditions.

* Extracted from a Paper read before the Chicago meeting of the American Foundrymen's Association.

† Research Engineer, Detroit Steel Casting Company.

* Lindstrom, R. L., "Obtaining Moulding Materials for the Steel Foundry," A. F. A. Trans., Vol. 29, 1920, pp. 202-212.

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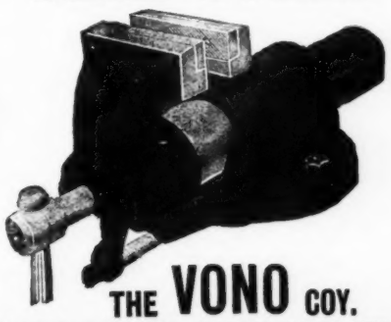

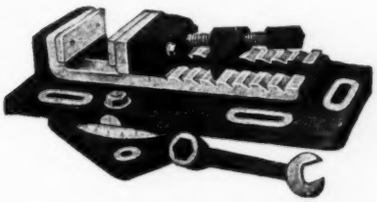

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relative values. The writer's own data are from transverse tests with cores made under shop conditions, and therefore not so definite as to ramming and drying conditions as is desirable. A check on the relative values of most of the materials was secured by a comparison with published data in researches on core binders. In order to get relative values it is necessary that the research cover two or more materials tested singly with sharp sand on the same kind of machine and that the results be expressed in the same units. From the work of H. L. Campbell* † relative figures on linseed oil and typical cereal binders were obtained, and from the work of C A. Hansen‡ relative figures on linseed oil, resin (in solution) and clay. The strength values were reduced to the basis of 1 of binder to 80 of sand by weight, which corresponds closely to 1 of linseed to 50 of sand by volume. Maximum figures, i.e., those based on best drying time and temperature and best moisture content, were used.

It was found that the ratios of relative values of bond corresponded fairly well with the ratios shown by the writer's tests, the actual strengths being higher for the cores tested under ideal conditions. On the strength of this check the writer's values for molasses have been included though not checked by the work of others. His tests on resin were made with the powdered material.

Linseed oil was taken as a base and 100 used to represent its dry bond value in the mixture given, 1 to 50 by volume, or 1 to 80 by weight. The values of the other materials reduced to the same strength mixture, 1 to 80 by weight, were referred to linseed oil at 100 and their value on this basis determined by simple proportion. The stronger materials—higher figures—were given a range in the table of 10 per cent. and the weaker materials—lower figures—a range of 20 per cent. above and below the figure determined.

Cost Figures.—The spread of the cost figures on some of the low strength binders is due to the 20 per cent. plus or minus range used in fixing their bond values. The figures for some of the materials appear high, compared to linseed oil (and they may be incorrect), but it must be remembered that one seldom demands the strength from cores made from other materials that is done from oil cores, that the impression of the high binder cost of oil sand cores is based on a high strength core.

Destruction of Bond.—The temperatures given for destruction of dry bond strength refer to the destruction of the bond in the mould by the heat of the molten metal and not to burning of cores or moulds in drying. These temperatures are, of course, approximate and are put 25 to 80 deg. C. above the temperature at which the bond begins seriously to deteriorate in baking.

Condition after Drying.—The hardness of the core or mould after drying will vary with the moisture content and the strength of the mix. It indicates the ability of cores to stand handling and to retain their sharpness of outline and also gives some indication of the resistance to the cutting action of the metal during pouring.

Behaviour of Bond at High Temperatures as to Hardness before Destruction and Nature or Rapidity of Collapse.—These are not very well known but plainly very important properties in their effect on the resulting casting. They largely determine resistance to shrinkage, ease of removal of sand and surface secured. The practical foundryman's judgment regarding them is quite good, as shown by his choice of materials for various jobs. The properties listed are an interpretation of this judgment and of the known properties of the materials.

Data of this nature are likely to have as a background the practice prevailing at the foundry of the observer, and probably have been so influenced in this case. In this connection, the materials chosen for discussion were those with which the writer was most familiar. The list of materials was not intended to be complete.

Ease of Removal and Surface Resulting.—The ease of removal of sand and the casting surface resulting will vary with the proportion of binder to sand and with the presence of other binders. Two or more binders are often used in the same mix, and the effect of one may predominate. Also, the size of the sand section and of the metal section greatly influence the temperature reached by the sand, and hence the final result.

Discussion and Conclusions.—There are several specific questions regarding use of materials which will be offered for discussion, some general deductions will be attempted, and some comments made and theories advanced on the happenings in moulds and cores under certain conditions.

The questions which suggest themselves are:—(1) Does resin actually give a core flexibility or softness under heat?; (2) is there a cheaper material per unit bond than resin which will accomplish the same purpose?; (3) if resin does give a core soft under heat, is it logical to use fireclay with resin to give green bond?; and (4) does resin and oil actually give a better "peel" or a shiny surface on the casting? If so, should cores of this material be washed with silica wash?

High Temperature Materials.

Analysis of the tabulated properties shows that silica flour and fireclay are the two materials which contain the least volatile or combustible matter and the largest per cent. of mineral matter. Therefore they undergo the least change at high temperatures and are the chief ingredients used with silica sand in moulds and cores which will be raised to high temperature by heavy metal sections or long exposure to the metal in pouring. Both fireclay and silica flour are used in moulds, and usually only silica flour in cores for these severe conditions.

In addition to having a high mineral content, fireclay withstands the highest temperature of any of the binders before losing its bond, and even then the collapse or loss of strength is gradual. Silica flour has no dry bond strength, but gives the impression of strength by hardness and compactness. When bonded with molasses water or oil a high content of silica flour, like fireclay, gives the sand the ability to retain its shape, and its collapse is very gradual, even after the oil or molasses bond is destroyed.

The other binders, unless accompanied by fireclay or a high silica flour ratio, are used for sand sections which will not reach a temperature sufficient to destroy the bond while the metal is still molten. So these two materials, fireclay and silica flour, are the ones by which to judge progress and limitations in coping with high sand temperatures.

Some of the properties of silica flour have just been indicated. In high proportions it greatly decreases the permeability of the sand. It gives a sand mixture which can be compacted very closely and made very hard and impervious to metal. Such a compact core is quite difficult to remove in cleaning the casting. It appears to improve the ease of cleaning and the surface secured, when used in smaller amounts in oil-bonded cores.

Silica flour does not tend to lower the fusion point of the sand as fireclay does. It only adds more finely divided material of the same fusion point. But there is seldom fusion of a good sand-fireclay mix, so it is doubtful if the beneficial effects of silica flour are due to any effect on the refractoriness of the mix. The improvement is probably due either to the slower collapse of the mould or core or to the greater closeness and hardness conferred by silica flour.

Fireclay, as stated, withstands the highest temperature of any of the binders before losing its bond. When the bond is destroyed, the change is evident by the easier erosion of the surface, but there is no collapse. Permeability cores (A. F. A. test specimens) of sand and fireclay mixtures, *i.e.*, of facing sand, show considerable compressive strength after baking at 870 deg. C.—about 40 per cent. of the maximum strength. The hardness begins to decline at about 340 deg. C., but is still satisfactory at 455 deg. C. These properties explain the desirability of fireclay for bonding dry-sand moulds. It will withstand temperatures sufficiently high to permit rapid and certain driving off of all gases, sometimes including the combined water of the clay itself, without collapsing. This is no doubt due to the large amount of incombustible or mineral matter in the fireclay. The bond or plasticity may be destroyed by driving off the combined moisture, but the bulk is still present in the sand mixture and the effect of compacting still evident.

But when the bond is destroyed the hardness declines and the mould surface is subject to erosion. Dr. Moldenke states that this decomposition of the clay bond is the cause of the cutting of the sand at the gate in green sand moulds with the consequent washing of sand into the casting.*

What is needed, then, as an improvement over the present materials is a material which will retain its bond at very high temperatures, or which will cause the sand mixture to glaze at high temperatures or surface harden.

Fusion, Penetration or Vitrification.

Sand-fireclay mixture is an impure silica-alumina mixture. If one takes the lowest temperature at which a pure silica-alumina mixture begins to fuse† (1,540 deg. C.), there is a temperature range somewhat lower than the high pouring temperature range. But the steel must furnish the heat to raise the temperature of the sand mix to the fusion point, and it is doubtful if steel leaving the nozzle between 1,565 and 1,590 deg. C. will flow through the gate, fill a cold mould, surround a core and raise the temperature of the core to 1,535 deg. C. Of course, there is the influence of pressure and the fact that the sand mix is a poor conductor of heat on the one hand, but on the other one is not sure of the high temperature measurements, especially of pouring temperatures within a range of about 27 deg. C., so all of this is somewhat speculative.

The explanation more commonly given for cores seemingly fused and very difficult to remove is that the steel has penetrated the core, flowing in between the grains of sand, and that the hard core is a mixture of sand and steel. This view is supported by observations of shop men that the high silica flour-sand mixtures are most successful in those cores surrounded by a heavy mass of metal, when the core is rammed or packed, layer by layer, giving a very hard and tight core.

Cores which are a mixture of steel and core material undoubtedly do occur and cannot well be questioned when supported by an analysis showing a high iron content.

However, the writer recently observed some cores which were very difficult to remove from large castings and which were called an example of metal penetrating the core, which seemed on examination to be a case of vitrification of the material. It was observed that one of the pieces removed showed the contour of the original core, which would not be expected if the metal penetrated the core from the sides. The density or specific gravity of the material was 2.3, compared to about 2.0 for claybrick and 7.8 for steel, and the pieces appeared like pieces of stone. This core was of a sand mixture containing clay. Another core of a silica flour sand mixture showed pieces like fragments of silica brick. It is assumed that the material at the high temperature and under the pressure which must have existed baked or vitrified into a kind of firebrick in the first case and a silica brick in the second case.

Supposedly, steel foundries use a non-vitrifying clay, but inasmuch as silica sand can be made into a silica brick, it is assumed that all fireclays will vitrify somewhat under pressure, and that if a really vitrifying type of clay had been used the core would have been still more difficult to remove.

But brick can be readily enough broken and chipped even though hard. It is the fact that these cores are confined that makes them so difficult to remove. The thought suggests itself that if such cores could be made with a large vent or opening through the centre, or possibly a soft sand centre, and the metal kept out of these vents or openings, the cores, though vitrified, would be much easier to remove. All of which recalls the opening comment that what is needed is not usually higher melting point materials, but better application of those available.

---

* Campbell, H. L., "The Qualities of Commercial Core Oils," A. F. A. Trans., Vol. 33, 1925, pp. 2-82.

† Campbell, H. L., "Methods of Determining the Properties of Cores Made with Cereal Binders," A. F. A. Trans., Vol. 34, 1926, pp. 558-566.

‡ Hansen, C. A., "Some Properties of Core Oils," A. F. A. Trans., Vol. 34, 1926, pp. 577-610.

* Moldenke, R., "Permanent and Long Life Moulds," A. F. A. Trans., Vol. 34, 1926, pp. 204-210.

† Trainer, D. W., "Some Experiments on the Refractoriness of Foundry Sands," Vol. 34, 1926, pp. 327-354.

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Specification. No.	Specified Chemical Composition.[1]	Description.	Minimum Tensile Properties.[2] Ultimate tens. str. Tons sq. in.	Per cent. elongation in 2 in.
3L11	*Copper* 6% to 8% ... *Tin* may be used up to 1%	Casting alloy	9	3
2L8	*Copper* 11% to 13% ...	Casting alloy	9	Nil
2L5	*Zinc* 12.5% to 14.5% *Copper* 2.5% to 3.0% ...	Casting alloy	11	3
L24	*Copper* 3.5% to 4.5% *Nickel* 1.8% to 2.3% *Magnesium* 1.2% to 1.7%	"Y" alloy castings	11	Nil

[1] In each of the above alloys the remainder consists of aluminium and normal impurities.
[2] Tensile tests for casting-alloys are made on specimens machined to .564 in. diameter from samples cast 1 in. diameter in a heated iron chill. Tensile tests for sheet are made on stamped specimens with width ½in. to 1½ in., and parallel length 2½ in.

F.T.J. 18/6/27.

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SIX STEEL FURNACES have been lit at the Cwmfelin Works, Swansea.

A FIRE OCCURRED at the Broad Oakes Ironworks, Chesterfield (Markham & Company, Limited), on November 20, involving the boiler shop. The damage was not heavy.

THE BARROW CORPORATION has placed an order with Metropolitan Vickers, Limited, for a 7,500-kilowatt electric plant, costing £30,000, for the works extension sanctioned by the Electricity Commissioners.

THE SYNTHETIC AMMONIA AND NITRATES COMPANY, a branch of the Imperial Chemicals Industries, are to place an order with Dorman, Long & Company, Limited, of Middlesbrough, for 25,000 tons of steel for the construction of new works at Billingham, on the north bank of the Tees.

THE DIRECTORS of the Leeds Fireclay Company, Limited, propose to increase the capital of the company to £500,000 by the creation of 100,000 additional preference shares of £1 each, ranking for dividend and in all other respects *pari passu* with the existing preference shares in the company.

MEETINGS of the preference and ordinary shareholders of Sir William Arrol & Company, Limited, were held in Glasgow on Friday week to consider the directors' proposals for dealing with the debit at profit and loss. The proposals included the writing down of the ordinary capital from £296,700 in £10 shares to £118,680 in £1 shares, £6 per share being cancelled, also a cancellation of all preference arrears in compensation for which the preference dividend would be raised from 6½ per cent. to 7 per cent. The proposals were approved.

IN RECOGNITION OF long and faithful service, presentations were made on Monday to 27 employés of Elliott's Metal Company, Limited, Selly Oak, Birmingham, who had completed 50 years' service or more with the firm, the chairman of the company, Alderman J. Archibald Kenrick, in the presence of a large gathering of workpeople, handing a handsome presentation to each employee who had qualified. A remarkable fact was that in one family three brothers who had worked for the company had an aggregate of 157 years' service. Two other families produced two brothers who had worked in the aggregate 115 and 107 years respectively. The longest record of service was 62 years made by George Withersford.

REFERENCES ARE MADE in the annual report of Baldwins, Limited, to the Advisory Committee on the company's affairs alluded to by the chairman (Col. Sir William C. Wright) at the last annual meeting of shareholders. The Committee, the directors state, are continuing their investigation and hope to report early in 1928. The members of the Committee are Mr. J. W. Beaumont Pease, Mr. Nigel Campbell, Mr. A. H. Wynn and Mr. W. Mackinnon. In the meantime some important changes have been carried out both in the company's investment interests and in the internal organisation and control. These latter have been made with the approval of the Advisory Committee, and are stated to have resulted already in increased efficiency and considerable economy. For reasons of administration, Col. David Ellis Williams, Mr. James Spencer Hollings, Capt. Hector Leighton Davies and Col. Alan Sidney Whitehorn Dore have retired from the board to devote their whole time to the management of their respective branches and groups, but remain members of the executive committee. Mr. John Beaumont Neilson, chartered accountant, has been appointed to a seat on the board.

THE ANNUAL DINNER of the British Electrical and Allied Manufacturers' Association was held on November 18 in London, Lord Derby, president of the Association, in the chair. Lord Weir said that the Electricity Act of 1926 was passed with the most complete faith in the progress of Great Britain in a productive sense. The Act had been criticised because it did not affect distribution. He thought that it deliberately and definitely affected distribution by setting the distributor free to do his business of distribution. He must concentrate on the highly important duty of teaching people to apply electrical energy, to get "the electricity habit," and to feel that they could not do without it. He asked the railway companies to note that the power situation in this country was changing to their advantage. Let them revise their calculations in view of high tension energy becoming available all over the country at a low price. To the mining industry, with its coking, and he hoped later with its pretreatment plant, and to the iron and steel industry, he would say that in considering the perplexities of their energy economics it would be well to remember that a market would soon be available to absorb any kind of waste in the production of high-tension electricity. This was the first country in which that would be possible

SIR HENRY FOWLER (chief engineer of the London, Midland and Scottish Railway) was entertained at the Queen's Hotel, Birmingham, on Monday, at a complimentary dinner by the Midland Branch of the Institution of Mechanical Engineers, of which Institution he is president. Mr. G. N. Guest, who presided over a large and representative attendance, in submitting the toast of Sir Henry Fowler, stated that Mr. Challen, who attended the meeting at the Midland Institute when the Institution was transferred to London, was present. One thing that was wanted in Birmingham was a building where the civil engineers and mechanical engineers could meet. There was such a building available, and if the Institution would only find the money, that building could be secured. Sir Henry, in reply, stated that he started his engineering career in Birmingham, and greatly appreciated the value of the training he received at the Mason College. Engineers would never forget Birmingham's association with James Watt, without whom George Stevenson would never have been much value. Birmingham had produced some great engineers who were esteemed throughout the world. Respecting the Institution, membership was becoming stricter, and would be more highly valued as the days went by. A building for the housing of engineers in Birmingham would be a great asset.

Contracts Open.

Bicester, December 5.—One mile of 3-in. and 2-in. and about half a mile of 1-in. water mains, complete with a 14-ft. windmill, engine-house and petrol engine, and storage tanks complete with all necessary valves, etc., for the Bicester Rural District Council. Mr. H. B. Eames, South View, King's End, Bicester. (Fee £3, returnable.)

Darlington, December 15.—(a) Cast-iron pipes, from 2-in. to 6-in. diam., during six months ending June 30, 1928. Mr. W. R. Ware, clerk, 25, Northgate, Darlington. (b) Special small castings during 12 months ending December 31, 1928. Mr. H. Robinson, the engineer, Bishop Auckland. All for the Durham County Water Board.

Johannesburg, December 29.—One 5-ton three-motor electric overhead travelling crane, for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,506.)

London, S.W.1, December 2.—(1) Points and crossings, etc.; (2) pressed steel sleepers; (3) dogspikes, fishbolts, nuts and washers; (4) steel bearing plates for F.B. rails; and (5) cylindrical buffers, for the South Indian Railway Company, Limited 91, Petty France, Westminster, S.W.1. (Fees £1 for each of (1) and (2) and 10s. for each of (3), (4) and (5).)

London, S.W.1, December 9.—(1) Lathes; (2) four-wheeled petrol tank wagons; and (3) steel material (plates, channels, flats, etc.), for the Bombay, Baroda and Central India Railway Company. The Offices, The White Mansion, 91, Petty France, Westminster, S.W.1. (Fee £1 each for (1) and 10s. each for (2) and (3), all non-returnable.)

Manchester, December 5.—(B. 59) Steel valves and traps for high-pressure steam and water, for the Electricity Committee. Mr. H. C. Lamb, chief engineer and manager, Electricity Department, Town Hall, Manchester. (Fee £1 1s., returnable.)

Middlesbrough, December 3.—Castings (steel and iron), bolts and nuts, brass and copper work, for the Tees Conservancy Commissioners. Mr. J. H. Amos, general manager, Middlesbrough.

Stratford-upon-Avon, December 14.—Pumping plant, for the Corporation. Mr. F. W. Jones, borough surveyor and water engineer, Sheep Street, Stratford-

The Williams Prize of the Iron and Steel Institute.

On his retirement from the Hon. Treasurership of the Iron and Steel Institute in 1926, Mr. Illtyd Williams founded the "Williams Prize," intended especially to encourage men on the technical staffs of iron and steel works in the United Kngdom and the Dominions to offer to the Institute Papers of a practical character. The Council has now proceeded to make the first award of this prize, and the money available has been divided as follows:—

To Mr. E. A. Atkins (Ryland Bros., Warrington), the sum of 50 guineas for his Paper on "The Drawing of Steel Wire and its Relation to the Qualities of Steel" (May, 1927), and to Mr. C. S. Gill (Consett Iron Company), the sum of 30 guineas for his Paper on "The Effect of Ash in the Coke on Blast-Furnace Working" (September, 1927).

Company Reports.

Platt Bros. & Company, Limited.—No interim dividend on ordinary shares.

Shotts Iron Company, Limited.—Dividend, 5 per cent. for year on ordinary shares.

Sheffield Steel Products, Limited.—Debit balance, £21,444; debit brought forward, £6,667.

Electric Construction Company, Limited.—Interim dividend, 6 per cent. per annum on ordinary shares, less tax.

Brown, Bayley's Steel Works, Limited.—Balance standing to credit revenue account, inclusive £6,915 brought forward, £33,083; one year's dividend on preference shares, £25,000, discharging arrears down to July 31, 1925; carry forward, £8,083.

Baldwins, Limited.—Balance of manufacturing and trading account for year, £120,000; brought forward, £241,489; total, £361,498; expenditure for alterations and improvements at works and developments of mines, £24,873; interest on 4½ per cent. debenture stock, £22,500; interest on 7½ per cent. debenture stock, £162,233; sinking fund premiums for redemption 4½ per cent. debenture, and depreciation of leaseholds, £11,357; sinking fund for redemption of 7½ per cent. debenture—year to date, £29,017; transferred to general reserve, £56,221; credit balance forward, £55,297.

Henry Bessemer & Company, Limited.—The directors state that it is necessary to reduce the capital of the company in order to write off the debit of £64,286 at profit and loss account on December 31 last and to write down the works and plant to present-day value. It is proposed to write down the 233,500 issued ordinary shares from £1 to 6s. 8d. each. This will provide £155,667, to which £5,287 will be added from reserve, making a total of £160,954. By this means the debit balance can be written off, and it is suggested that the book value of the company's works be reduced from £267,408 to £171,128.

Dorman, Long & Company, Limited.—The report for the year ended September 30 last states that the profit amounted to £273,338, which it is proposed to deal with as follows:—Interest on 4 per cent. first debenture stock (£16,000); on 5½ per cent. redeemable debenture stock (£214,376); dividend on the 6 per cent. cumulative preference shares for 15 months to September 30 last (£38,854); directors' fees to September 30 last (£2,000); and balance carried forward, £2,108. The report states that the results of the coal stoppage of last year continued well into the early part of the 12 months now covered, and considerable losses were incurred in the first half-year's working. The profits earned during the second six months have been sufficient to wipe off these losses and to have a balance of profit sufficient to pay debenture interest, and also the dividend on the cumulative preference shares.

Slagging of Iron and Manganese.

In the course of a summary of Report No. 128, "Relations between Slagging of Iron and Manganese in Basic-Bessemer Process," of the Steelworks Committee of the Association of German Ironmasters in "Achiv für das Eisenhüttenwesen," DR. E. FAUST (Clausthal) points out that in this Report it is sought to determine in broad outlines the behaviour of manganese and iron in the refining process with the help of physico-chemical laws, particularly under the conditions prevailing in the basic-Bessemer process. In view of the far-reaching uniformity in the composition of the slag when the blowing is completed and of the approximately uniform temperature, the inference is drawn by the author from his researches and the curves plotted representing the results obtained, that a dependence exists between the quotient Mn: Fe in the slag and the quotient Mn: Fe in the metal bath.

From the law thus obtained it may be deduced that the proportion of manganese in the slag in relation to the total amount of manganese present, is in ratio to the proportion of iron in the slag in relation to the total amount of iron present.

The author next endeavours to apply the same law to the acid-Bessemer process. In this case also the validity of the relationship is found to be confirmed, while it is further established that in the case of the acid-Bessemer slag, which is entirely different in structure from the basic-Bessemer slag, another constant K holds good for the relationship in question.

In conclusion, the possibility is suggested of applying these laws to the open-hearth and all other metallurgical processes.

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Our photograph is a convincing demonstration of the "green" strength of "Pyrolyte" joints.

The picture shows two firebricks cemented end to end with "Pyrolyte" and allowed to set cold.

The joint is here seen supporting a 10-stone man, but it would have supported three others without breaking!

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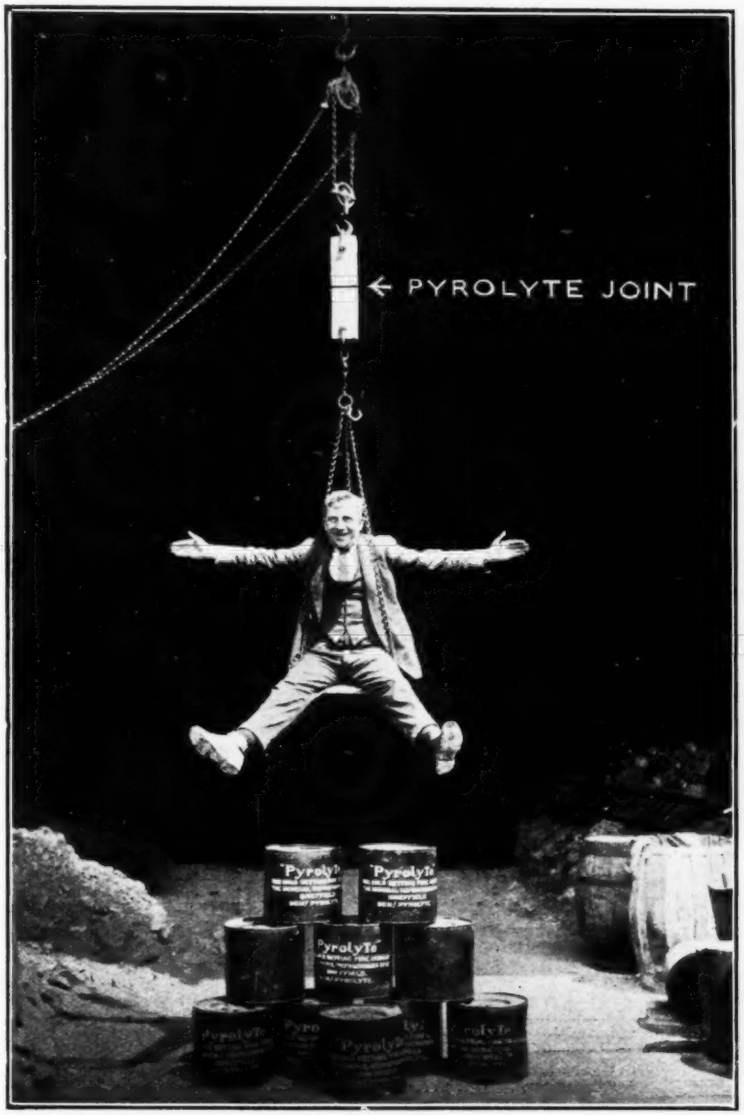

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The joint is, moreover, highly resistent to corrosion by slag or ash.

A firebrick wall set in "Pyrolyte" is truly MONOLITHIC and, if the exposed face is "washed," with a thin coating of the cement, the life is thereby prolonged to a remarkable extent

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Iron and Steel Markets.

Pig-iron.

MIDDLESBROUGH.—The near approach of the end-of-the-year holidays has, as usually expected, had a quietening effect upon business in the Cleveland iron markets, although some of the Tees-side ironmasters are already pressing forward preparations for a further expansion of production early in the coming year. The present position of the iron trade on the North-East Coast, it is fully believed, amply justifies a further increase of furnace outputs, present consumption of Cleveland pig being about equal to current production, and, with stocks now almost completely liquidated, it appears reasonably certain that additional plants will be required to cope with the increased demand anticipated early in the New Year. So far shipments of iron from local ports for November show an increase over the October figures, while the total would have been doubtless enlarged but for inclement weather conditions on the coast during the latter half of the month. Still, exports of foundry iron are a little better, and there has been rather more business with Scotland, despite the offer of foreign iron at much lower prices. Cleveland prices are all very firmly maintained as follow:—No. 1 foundry iron, 67s. 6d.; No. 3 G.M.B., 65s.; No. 4 foundry iron, 64s.; No. 4 forge, 63s. 6d. per ton.

A more hopeful view is also entertained of the position of the East Coast hematite industry, and although business is not precisely active, the lower prices now current are favourable to further early improvement. Quotations are steadier than of late, but for small lots makers are holding out for 71s. 6d. for mixed numbers and 72s. for No. 1 quality. On the North-West Coast Bessemer mixed numbers are still quoted at 72s. per ton at works.

LANCASHIRE.—Quiet conditions continue the rule in the local market for foundry pig, current transactions being small in number and, as a rule, relating to odd lots for delivery within the next few weeks, new contract commitments being almost unheard of. Recently offers of Scottish pig have been made down to 88s. per ton, for delivery Manchester or equal, Derbyshire iron at 73s. 6d. to 74s., with Staffordshire makes from 73s. to 73s. 9d. and Cleveland No. 3 at 78s. 2d., including delivery in each instance.

THE MIDLANDS.—The demand for foundry pig in this area is still unsatisfactory, but there has been no further easing in the matter of prices, which remain as follow:—Derbyshire No. 3 is quoted at 65s. to 66s. at furnaces, Northampton at 60s. to 60s. 9d., and North Staffordshire at 64s. 6d. to 65s. 6d., f.o.t. Cleveland No. 3 foundry iron is at 80s. 9d., and Lincolnshire No. 3 just under 80s., delivered stations in this district. Scotch iron is unaltered in price, and small supplies are coming into the Midlands round about 92s. 6d. per ton.

SCOTLAND.—Foundries, generally, in this area are extremely short of work, with the usual result that pig-iron is in slow demand. The recently-discussed reduction in the make of Scotch pig-iron has commenced by one furnace at Ardeer being put out of operation. There is no definite news of any others going out yet, but the possibilities remain. The price of No. 3 Scotch foundry remains unchanged at 72s. at furnaces.

Finished Iron.

Reports from manufacturing firms in this branch of industry indicate little improvement in business generally, and in South Staffordshire makers of crown and common bars complain of a shortage of orders in their books. There is a wide divergence in quotations for crown iron, which vary from £9 7s. 6d. to £10 5s. per ton. Nut-and-bolt iron is being quoted at round £9 delivered. Little support is being given to the South Staffordshire mills for bolt iron, as, owing to the wide disparity between the local and the Continental prices, the consumers are obliged to purchase the foreign product, which is being quoted here at £5 15s. to £5 17s. 6d. Staffordshire marked bars are unchanged at £13 at makers' works, and it is reported that business is somewhat better with the makers of this iron, who are at present moderately occupied. The works who cater for the crown and cheaper grades can only keep the mills going irregularly.

Steel.

The outlook for the steel industry generally is rather more favourable than lately reported, and at Sheffield a fair volume of business has been recently noted. Acid billets are a much better feature than basic, the latter having tailed off very badly. Prices remain as previously given. Continental competition hampers sales, although the weight of foreign billets bought here cannot be described as heavy. Open-hearth steel production is on a much smaller scale, but for special qualities the demand is showing some expansion. Stainless steel is a good feature, and so is tool steel. The call for railway and shipbuilding steel is better, and the lighter sections of the steel industry are quite well employed at present. In the tinplate market makers' quotations may now be called firm at 17s. 9d. to 18s. basis for coke tinplates in approved specifications, with usual option of lights and crosses, and 3d. basis extra for squares and odd sizes, net cash, f.o.b. Welsh ports.

Scrap.

Conditions in the principal markets for scrap metal may perhaps be best described as lifeless in the extreme, very few consumers coming forward with buying orders at this season, while holders of stocks as a rule are by no means eager sellers at the prices now ruling. In the Midlands, 70s. per ton delivered can still be obtained for machinery scrap, broken into cupola sizes, and 55s. per ton delivered for light cast-iron scrap. In Scotland, cast-iron scrap is unchanged, and first-quality machinery is still around 67s. 6d. per ton, with heavy ordinary 5s. per ton less. Old cast-iron railway chairs in some cases are being offered even at higher prices than machinery, the quotations varying from 65s. to 67s. 6d. per ton. Light cast-iron scrap has weakened slightly, and the price is now around 53s. 6d. to 55s. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—With the exception of a temporary relapse towards the close of last week's markets, values of warrant copper have had a steadily advancing tendency, evidencing increasing confidence both at home and abroad, as expressed in the volume of business now reported daily. The Combine's price in the London market for forward metal has been well within open market quotations, and it would appear that buyers in some cases have found some difficulty in securing all the copper they wanted.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £58 17s. 6d. to £58 18s. 9d.; Friday, £59 2s. 6d. to £59 3s. 9d.; Monday, £59 6s. 3d. to £59 7s. 6d.; Tuesday, £59 1s. 3d. to £59 2s. 6d.; Wednesday, £59 8s. 9d. to £59 10s.

Three Months: Thursday, £59 2s. 6d. to £59 3s. 9d.; Friday, £59 6s. 3d. to £59 7s. 6d.; Monday, £59 10s. to £59 11s. 3d.; Tuesday, £59 6s. 3d. to £59 7s. 6d.; Wednesday, £59 13s. 9d. to £59 15s.

Tin.—To some extent, conditions in the standard cash tin market have been rather more favourable, and it was not exceptional to anticipate that a certain amount of recuperation will ensue after a very severe depression. There is no doubt that recent arguments bearing on the growth of production in Malaya and reduced activity in the American manufacturing trades were rather exaggerated. The statistical position is still practically on a level with this time last year, when tin was selling at a much higher level.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £265 15s. to £266; Friday, £266 5s. to £266 10s.; Monday, £267 to £267 2s. 6d.; Tuesday, £267 7s. 6d. to £267 10s.; Wednesday, £268 to £268 5s.

Three Months: Thursday, £263 15s. to £264; Friday, £264 10s. to £264 15s.; Monday, £265 10s. to £265 12s. 6d.; Tuesday, £265 7s. 6d. to £265 10s.; Wednesday, £265 2s. 6d. to £265 5s.

Spelter.—In connection with ordinary spelter, a merchant concern states that sellers have shown some reserve in face of a moderate demand and a little bear covering. Reports from the Continent have ruled quiet, and indicate no very definite tendency in either direction. Generally speaking, the outlook is regarded a little more favourably, and some further advance may take place.

The following are the week's prices:—

Ordinary: Thursday, £26 11s. 3d.; Friday, £26 12s. 6d.; Monday, £26 15s.; Tuesday, £26 12s. 6d.; Wednesday, £26 12s. 6d.

Lead.—The market for soft foreign pig maintains the improving tendency recently noted, and confidence seems to be returning slowly. The relatively low price to which lead has fallen, while it may not have caused any decrease in production, does not seem to have checked any increase. The intrinsic position is, therefore, healthier, and it may well be that before long the improvement in the position will be reflected by a further recovery in values.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £21 7s. 6d.; Friday, £21 8s. 9d.; Monday, £21 12s. 6d.; Tuesday, £21 16s. 3d.; Wednesday, £22.

Compressed Air Explosion at Deptford Green.

On January 7, 1927, whilst a 20-ft. diameter pit was being excavated and lined with cast-iron tubbing by the underpinning method, the steel deck, capping the shaft, was blown off and five of the six men inside the shaft were killed. The pressure within the shaft at the time was not more than 13 lbs. per sq. in. above atmosphere and the cause of the failure was ascertained only after close investigation of all the circumstances by two of H.M.'s Inspectors of Factories.

Their Report deals with the many possible causes suspected of originating this disaster, such as an explosion of oil from compressors, of methane, of hydrogen, or of bombs dropped during the war. All of these seemed, at first, more likely to account for what happened than the ascertained cause, namely, mechanical weakness in the apparently strong design of the structure which was discovered upon expert examination.

It was found that the attachment of the steel deck to the cast-iron shell, lining the pit, through the flanges usual on cast-iron tubbing, set up unexpectedly high stresses in the shell by reason of the bending effect. The girder work of the deck had also had the effect of concentrating the load mainly at certain points of the circle. Cast iron had been exposed to a much higher tension than was realised, and its unreliability under considerable tension has again been demonstrated by this occurrence.

The Report contains numerous drawings illustrating the arrangements existing prior to the accident, together with important Appendices giving the results of tests of the material by the National Physical Laboratory, and by Messrs. Burstall & Monkhouse, and quoting in full independent reports by Dr. Lowe-Brown, Consulting Civil Engineer, and by Professor Coker, whose special photo-elastic methods of determining complicated stresses by the aid of models are well known. These reports confirmed the conclusions which had been reached by the Inspectors, who make recommendations as to the avoidance of similar catastrophes in the future. In addition, reference is made to previous failures (accompanied by loss of life) which it is believed were attributable to causes of a similar character.

A New Foundry Concern.

A new foundry company has been formed, to be known as S. E. Dawson & Company, Limited, with offices at 94, Market Street, Manchester, and works at Hulme Hall Lane, Miles Platting, Manchester. Mr. Dawson, who, until recently, was foundry manager to Ferranti, Limited, is also conducting from this address a practice as a foundry consultant and metallurgist. The 'phone number is City 4979, and the telegraphic address, "Sedfic" Manchester.

* Report on a Compressed Air Explosion which occurred on January 7th, 1927, at a Shaft sunk by the Foundation Company, Limited, Agents for the London Power Company, Limited, at Deptford Green; by R. U. Shaxby, B.A., B.Sc., Assoc. M.Inst. C.E., H.M. Inspector of Factories for the Woolwich District, and L. C. McNair, B.Sc., H.M. Engineering Inspector of Factories (Report No. 1853). Price 5/-, by post, 5/4.

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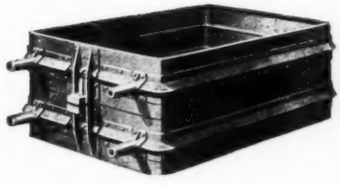
In every class of Foundry and in every Moulding Box service Sterling Boxes soon show their marked superiority, not only in the better quality of work produced but also in increased output per man per hour.

Cast-iron Boxes are excessively heavy, and liable to break at any moment. Boxes made from sheet metal are too flimsy to stand up to the heavy duties of general foundry service.

There is only one remedy . . . the Sterling Rolled Steel Box, with the solid centre reinforcing rib and two stiff sand-retaining ledges. They are light, strong, rigid, accurately made on up-to-date machinery. Cannot crack or break. Cannot distort or get out of truth.

Send your next Moulding Box enquiry to the leading Moulding Box Manufacturers.



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COPPER.

	£ s. d.
Standard cash	59 8 9
Three months	59 13 9
Electrolytic	65 0 0
Tough	63 0 0
Best selected	63 10 0
Sheets	88 0 0
India	73 10 0
Wire bars	65 0 0
Do. December	64 13 9
Do. January	64 13 9
Ingot bars	64 13 9
H.C. Wire rods	69 10 0
Off. av. cash, Oct.	55 3 0⅝
Do. 3 mths., Oct.	55 5 3⅜
Do., Sttlmnt., Oct.	55 2 11½
Do., Electro, Oct.	62 8 9
Do., B.S., Oct.	61 18 9
Aver. spot price, copper, Oct.	55 2 11¾
Do., Wire bars, Oct.	62 12 4½
Solid drawn tubes	12¾d.
Brazed tubes	12¾d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	9¼d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	268 0 0
Three months	265 2 6
English	266 10 0
Bars	268 10 0
Straits	273 10 0
Australian	273 10 0
Eastern	269 0 0
Banca	277 0 0
Off. av. cash, Oct.	264 15 0½
Do., 3 mths., Oct.	261 16 4½
Do., Sttlmt., Oct.	264 14 9½
Aver. spot, Oct.	264 15 0½

SPELTER.

	£ s. d.
Ordinary	26 12 6
Remelted	25 15 0
Hard	20 10 0
Electro 99.9	30 15 0
English	27 0 0
India	22 0 0
Zinc dust	35 0 0
Zinc ashes	9 0 0
Off. aver., Oct.	26 15 3¼
Aver., spot, Oct.	26 17 11¼

LEAD.

	£ s. d.
Soft foreign ppt.	22 0 0
English	23 5 0
Off. average, Oct.	20 14 3½
Average spot, Oct.	20 9 7

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	35 0 0
Do. V.M. ex whf.	33 10 0
Rods	42 0 0
Boiler plates	30 10 0
Battery plates	32 0 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	64 10 0
Chinese	41 10 0
Crude	37 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	23 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%..	8 17 6 to 9 0 0
45/50%	12 15 0 to 12 17 6
75%	20 0 0 to 22 0 0
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11½d
Ferro-phosphorus, 20/25%	£17 15 0
Ferro-tungsten—	
80/85% c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/8 lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£23 0 0
6/8% car.	£22 17 6
8/10% car.	£22 5 0
Ferro-chrome—	
Max. 2% car.	£35 17 6
Max. 1% car	£41 12 6
Max. 0.70% car	£53 0 0
70% carbonless	1/4 lb.
Nickel—99% cubes or pellets	£175 0 0
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	2/11 lb.
Ferro-manganese (net)—	
76/80% loose	£13 0 0
76/80% packed	£14 0 0
76/80% export	£12 0 0
Metallic manganese—	
94/96% carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 6
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.
South Wales—	
Hvy. steel	2 18 6 to 3 0 0
Bundled steel and shrngs.	2 12 6 to 2 17 6
Mixed iron and steel	2 12 0 to 2 13 6
Heavy cast iron	2 17 6 to 2 18 6
Good machinery for foundries	3 2 6
Cleveland—	
Heavy steel	2 17 6
Steel turnings	2 6 0
Cast iron borings	2 3 0
Heavy forge	3 12 6
Bushelled scrap	3 3 0
Cast-iron scrap	3 2 6 to 3 6 0
Lancashire—	
Cast-iron scrap	3 5 0
Hvy. wrought	3 2 6
Steel turnings	2 2 6

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	46 0 0
Brass (clean)	39 0 0
Lead (less usual draft)	18 10 0
Tea lead	16 0 0
Zinc	16 10 0
New aluminium cuttings	76 0 0
Braziery copper	46 0 0
Gunmetal	48 0 0
Hollow pewter	170 0 0
Shaped black pewter	130 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	67/6
Foundry No. 3	65/-
Foundry No. 4	64/-
Forge No. 4	63/6
Hematite No. 1	72/-
Hematite M/Nos.	71/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/-
,, d/d Birm.	91/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	62/6
,, No. 3 fdry.	64/- to 65/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	54/-
,, fdry. No. 3	60/- to 60/9
Derbyshire forge	60/-
,, fdry. No. 3	65/- to 66/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	72/-
Hem. M/Nos.	76/-
Sheffield (d/d district)—	
Derby forge	66/-
,, fdry. No. 3	68/-
Lincs. forge	66/-
,, fdry. No. 3	68/-
E.C. hematite	85/-
W.C. hematite	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	74/-
Northants foundry No. 3	—
Dalzell, No. 3	100/- to 102/6
Summerlee, No. 3	88/- to 94/-
Glengarnock, No. 3	88/- to 94/-
Gartsherrie, No. 3	88/- to 94/-
Monkland, No. 3	88/- to 94/-
Coltness, No. 3	88/- to 94/-
Shotts, No. 3	88/- to 94/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	9 15 0	to 10 15 0
Angles		—
Tees to 3 united ins.		—
Nut and bolt iron		9 0 0
Hoops		12 10 0
Marked bars (Staffs.) f.o.t.		13 0 0
Gas strip		12 0 0
Bolts and nuts, ¾ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 2 6	to 8 7 6
Boiler plts.		10 10 0
Chequer plts.		10 5 0
Angles		7 12 6
Tees		8 12 6
Joists		7 12 6
Rounds and squares, 3 in. to 5½ in.		7 15 0
Rounds under 3 in. to ⅜ in. (Untested)		8 0 0
		and upwards
Flats, over 5 in. wide and up		9 2 6
Flats, 5 in. to 1½ in.		8 2 6
Rails, heavy	8 2 6	to 8 7 6
Fishplates		12 10 0
Hoops (Staffs.)		10 10 0
Black sheets, 24g.		10 7 6
Galv. cor. shts., 24g.		13 12 6
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	£5 15 0	to 6 10 0
Billets, hard		8 2 6
Sheet bars	£5 12 6	to 5 15 0
Tin bars	£5 12 6	to 5 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2¼
Sheet to 10 w.g.	1 2⅝
Wire	1 3½
Rods	1 2¾
Tubes	1 8
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	19.76
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	16.00
Basic	19.50
Bessemer	19.76
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	41.00
	Cents.
Iron bars, Phila.	2.07
Steel bars	1.75
Tank plates	1.75
Beams, etc.	1.75
Skelp, grooved steel	1.75
Skelp, sheared steel	1.75
Steel hoops	2.30
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.65
Sheets, blue an'l'd., 9 and 10	2.10
Wire nails	2.50
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	12/-
Other Districts, foundry	
,, ,, furnace (basis)	13/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	17/9
,,	28×20	,,	35/6
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	17/1½
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—
Terneplates	28×20	—	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered, £18 10 0	to 19 0 0
Rolled Ord. £15 0 0	to £15 10 0
Nail rods £15 7 6	to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron £5 15 0	to £6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½% ..	.. 45%
Water	63¾% ..	.. 40%
Steam	60% ..	.. 35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov. 24 ..	58	17	6	inc.		3/9
,, 25 ..	59	2	6	,,		5/-
,, 28 ..	59	6	3	,,		3/9
,, 29 ..	59	1	3	dec.		5/-
,, 30 ..	59	8	9	inc.		7/6

Electrolytic Copper.

		£	s.	d.		
Nov. 24 ..	64	5	0	No change		
,, 25 ..	64	5	0	,,	,,	
,, 28 ..	64	15	0	inc.		10/-
,, 29 ..	64	15	0	No change		
,, 30 ..	65	0	0	inc.		5/-

Standard Tin (cash).

		£	s.	d.		
Nov. 24 ..	265	15	0	inc.		35/-
,, 25 ..	266	5	0	,,		10/-
,, 28 ..	267	0	0	,,		15/-
,, 29 ..	267	7	6	,,		7/6
,, 30 ..	268	0	0	,,		12/6

Tin (English ingots).

		£	s.	d.		
Nov. 24 ..	265	0	0	inc.		50/-
,, 25 ..	265	10	0	,,		10/-
,, 28 ..	266	0	0	,,		10/-
,, 29 ..	266	10	0	,,		10/-
,, 30 ..	266	10	0	No change		

Zinc Sheets (English).

		£	s.	d.		
Nov. 24 ..	35	0	0	No change		
,, 25 ..	35	0	0	,,	,,	
,, 28 ..	35	0	0	,,	,,	
,, 29 ..	35	0	0	,,	,,	
,, 30 ..	35	0	0	,,	,,	

Spelter (ordinary).

		£	s.	d.		
Nov. 24 ..	26	11	3	inc.		2/6
,, 25 ..	26	12	6	,,		1/3
,, 28 ..	26	15	0	,,		2/6
,, 29 ..	26	12	6	dec.		2/6
,, 30 ..	26	12	6	No change		

Lead (English).

		£	s.	d.		
Nov. 24 ..	22	10	0	No change		
,, 25 ..	22	15	0	inc.		5/-
,, 28 ..	23	0	0	,,		5/-
,, 29 ..	23	0	0	No change		
,, 30 ..	23	5	0	inc.		5/-

AVERAGE MONTHLY PRICES OF IRON HOOPS.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 5 0	6 10 0	6 3 4
1897	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0
1898	6 10 0	6 10 0	6 10 0	6 10 0	5 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	7 0 0	6 11 8
1899	7 0 0	7 0 0	7 0 0	7 0 0	7 12 6	10 12 6	8 12 6	8 12 6	8 12 6	9 2 6	9 7 6	9 17 6	8 2 6
1900	9 17 6	10 7 6	10 7 6	10 7 0	10 12 6	7 12 6	10 12 6	10 12 6	10 12 6	9 17 6	9 2 6	9 2 6	10 3 9
1901	9 2 6	8 2 6	8 2 6	7 12 6	7 12 6	7 12 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 11 8
1902	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1903	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1904	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1905	6 17 6	7 0 0	7 0 0	7 0 6	7 0 0	7 0 0	7 2 6	7 2 6	7 2 6	7 7 6	7 0 0	7 7 6	7 1 8
1906	7 10 0	7 17 6	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 7 6	7 15 10
1907	8 7 6	8 7 6	8 7 6	8 7 0	8 7 6	8 7 6	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 0 0	8 7 1
1908	8 0 0	7 10 0	7 10 0	7 10 6	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 6 8
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
1910	7 1 10½	7 6 3	7 7 6	7 7 0	7 7 6	7 7 6	7 7 6	7 7 6	7 7 6	7 6 3	7 5 0	7 5 0	7 6 5½
1911	7 5 0	7 5 0	7 5 0	7 5 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 8 9	7 10 0	7 10 0	7 6 1½
1912	7 12 6	7 12 6	7 12 6	7 15 0	7 15 0	8 2 6	8 2 6	8 2 6	8 12 6	8 12 6	8 12 6	8 15 0	8 2 3½
1913	8 17 6	8 17 6	8 17 6	8 17 0	8 17 6	8 17 6	8 17 6	8 7 6	8 7 6	8 7 6	8 7 6	7 17 6	8 12 6
1914	7 17 6	7 17 6	7 17 6	7 13 9	7 12 6	7 12 6	7 12 6	9 2 6	9 2 6	9 2 6	9 2 6	9 2 6	8 6 4½
1915	9 3 6	9 18 1	10 7 6	10 16 6	10 17 6	13 2 6	13 2 6	13 2 6	13 7 6	14 2 6	15 2 6	15 18 6	12 10 1½
1916	17 2 6	17 2 6	17 2 6	17 6 3	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 6 1½
1917	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1918	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1919	17 2 6	17 2 6	17 2 6	17 2 6	24 6 3	24 6 3	24 6 3	25 9 0	26 7 6	26 7 6	26 7 6	26 17 4	22 14 9
1920	28 0 0	28 12 6	33 15 0	35 5 0	35 15 10	38 17 6	38 17 6	38 17 6	38 17 6	38 17 6	36 17 6	36 17 6	35 14 9
1921	29 1 3	23 5 0	21 12 6	20 0 0	20 0 0	20 0 0	17 5 0	15 0 0	14 4 0	13 15 0	13 10 0	12 18 0	17 5 10
1922	16 5 0	15 13 9	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	13 4 6½
1923	14 0 0	15 0 0	15 0 0	15 0 0	15 6 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 16 0	14 15 0	14 18 3½
1924	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 13 9	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 12 4½
1925	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1926	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	12 10 0	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
ROYAL BLDS., FISHER ST., SWANSEA.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
20, SECOND LINE BEACH, MADRAS.
1, HONG KONG ROAD, SHANGHAI.

REGISTERED TRADE MARK

OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON
NADIR HOUSE, MACLEOD ROAD, KARACHI.
1 SHAREH SONK EL TEWFIKIEH, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD MIDDLESBROUGH

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SITUATIONS VACANT AND WANTED.

FULLY-EXPERIENCED FOUNDER, young and energetic, desires change, where keen business acumen and ability, together with strictest integrity and hard work, will bring fair return and opportunity for advancement.—Box 522, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MOULDER, young and energetic, desires position as Foreman or Assistant Foreman; thoroughly experienced in all classes of jobbing work, iron and brass; good technical training, McLain's System.—Box 520, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, a position by a young all-round Iron and Non-Ferrous Moulder; fully skilled in loam, green and dry sand moulding and core-making; Marine or General Engineering preferred.—Box 524, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATTERN PLATE MOULDER for Lancashire; must have had experience of making loose and plate patterns from lead and iron Originals for Stove, Grate and Range work; must be a smart worker.—Apply, state age, wage and experience, Box 526, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATTERN MAKER FOREMAN for Lancashire district, to take control of the Department, including Pattern Makers and Pattern Filers; must have experience in Stove Grate, Range and Light Castings work; used to control of men, strict disciplinarian, to produce patterns on an economical basis; state age, experience and wage required.—Box 528, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Chilled Roll Caster, experienced in making Calender Rolls, etc., up to five tons in weight; regular employment for a good man.—Reply, giving particulars of experience and salary required, to Box 504, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, an experienced Moulder, to take charge of the manufacturing of Chilled Calender Rolls up to five tons in weight; regular employment for a good man.—Reply, giving experience and salary required, Box 506, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENCIES.

ENGINEERING MERCHANT FIRM, having well-appointed Offices in Westminster, with qualified Secretarial and Technical Staff and Overseas Shipping connection, is prepared to act as London and/or Export Agents for a manufacturing firm.—Write, "T. J.," c/o J. W. VICKERS & COMPANY, LIMITED, 24, Austin Friars, E.C.2.

AGENTS ON COMMISSION, OR DISTRIBUTORS, wanted, all parts, calling on Foundries, for the Sale of "Metallic Phosphoro."—Write CHAS. HALL, 746, Seventh Street, Buffalo, N.Y., U.S.A.

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INFORMATION HANDBOOKS, Advice, and Cons. free; King's Patent Agency, Ltd.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146A, Queen Victoria Street, E.C.4. 40 years' refs. 'Phone: 0682 Central.

PROPERTY.

11 ACRES WORKS SITE—SHEFFIELD. 145,000 sq. ft. of SHOPPING, compact and convenient. Siding connections with L.M. & S. and L. & N.E. Rlys. Well-built and commodious Offices. Will sell whole or in lots to suit customers, or let on favourable terms. Unique opportunity for manufacturers.

Apply,

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

AUCTION SALE.

CITY OF WAKEFIELD.

SALE OF A VALUABLE, WELL-EQUIPPED MODERN FOUNDRY, WITH THE ADVANTAGE OF IMMEDIATE POSSESSION.

E. W. GLOVER is favoured with instructions from the receiver for Debenture Holders, J. L. D. Gibson, Esq., of Messrs. James Gibson & Sons, Chartered Accountants, Union Bank Chambers, Royal Street, Barnsley, to offer for SALE BY AUCTION, at the STRAFFORD ARMS HOTEL, Wakefield, on FRIDAY, 9th December, 1927, at Three o'clock in the Afternoon, subject to the General Conditions of Sale of 1925, and to such special conditions as will then be read,

THE VALUABLE FREEHOLD FOUNDRY AND PREMISES

known as

INGS WORKS, INGS ROAD, WAKEFIELD,

recently occupied by Messrs. Ironfounders, Ltd.

The Foundry is fully and well equipped, and capable of producing castings up to 20 tons. It is situated in the industrial centre of Wakefield, with frontage to Main Road and convenient to the Railways.

The Works are Electrically Driven by 50 H.P. Generator, and comprise

FOUNDRY, containing :—

NO. 1 BAY. 128 ft. by 44 ft., worked by 15-ton Electric Overhead Crane by Royce. Two Cupolas capable of producing 6 Tons per hour and 4 Tons per hour are driven by 27 h.p. and 14 h.p. Motors respectively.

NO. 2 BAY. 64 ft. by 48 ft., contains Core Stove, Core Benches, Loam Mixing Mill, Sand Mixer, Rotary Iron Fettler, Grinding Machine. Line Shaft driven by 36-h.p. Motor, Jib Crane.

NO. 3 BAY. 165 ft. by 30 ft., worked by 7½-Ton Electric Overhead Crane by Royce.

NO. 4 BAY. 165 ft. by 30 ft., worked by 7½-Ton Electric Overhead Crane by Royce.

TWELVE-TON WEIGHBRIDGE, by Denison & Sons, Leeds; PATTERN STORES; MODERN OFFICES and ample YARD ACCOMMODATION.

The Large Stock of Moulding Boxes, Equipment, and Motor Lorry are included in the Sale.

IMMEDIATE POSSESSION will be given.

The Foundry may be inspected during the usual business hours on any day prior to Sale.

Further particulars and Schedule of Equipment may be obtained from MESSRS. JAMES GIBSON & SONS, Chartered Accountants, Union Bank Chambers, Royal Street, Barnsley; the AUCTIONEER, 7, Tammy Hall Street, Wakefield; or from

MESSRS. RALEY & SONS,
Solicitors,
Regent Street, Barnsley.

MACHINERY.

MACHINERY PLANT, &c., FOR SALE.

EDWARDS' PATENT FACE AND PULLEY GRINDING MACHINE, on cast-iron stand; face wheel 14½ in. dia., rest for grinding.

No. 14 DOUBLE-ENDED FACE GRINDING MACHINE (Besly & Co.), with stones 15 in. dia.; two-swivel adjustable table.

28 in. DOUBLE DISC GRINDING MACHINE (Roberts Bros.), with three discs and press; tables 16 in. x 12 in.

DRY EMERY GRINDING MACHINES, all sizes.

Six first-class POWERFUL 4-CYLINDER STEAM WINCHES (Clark Chapman), with cyls. 11 in. x 12-stroke; suitable for 120 lbs. W.P.

DOUBLE CYLINDER HORIZONTAL STEAM WINCHES, single and double purchase type, with cyls. 4½ in. x 9 in. diam.; extremely large variety.

Six dish-ended LANCASHIRE BOILERS, by Thompson; 30 ft. x 8 ft.; reinsure for 150 lbs. per square inch working pressure.

Two LANCASHIRE BOILERS, 30 ft. x 9 ft.; reinsure 110 lbs. pressure.

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD.

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